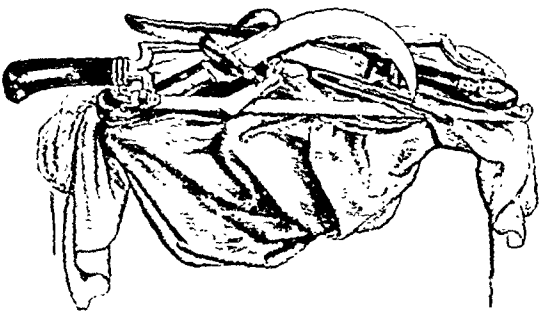
THE HISTORY AND EVOLUTION OF Surgical Instruments

By Dr. C. J. S. THOMPSON

WITH A FOREWORD BY DR. CHAUNCEY D. LEAKE



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Introduction

PROFESSOR C. J. S. THOMPSON needs no introduction to American readers. His many brilliant and exciting volumes dealing with various phases of medical history are well known to all who are interested in the subject. A special note is merited, however, by Mr. Henry Schuman's publication of the present volume.

Surgery is a great technical art. In applying scientific knowledge to desired therapeutic ends, the surgeon must be a skilled manipulator of exquisitely appropriate tools. This history of surgical instruments becomes thus the story of the development of the essential technique of surgery. Many great surgeons, from Renaissance masters to the great moderns, have dealt with various phases of this development. But no one has done it in as comprehensive and as detailed a manner as Doctor Thompson. His survey was made possible largely through the remarkable collection of surgical instruments in the collections of the Royal College of Surgeons of London.

Those familiar with the sedate but modest facade of the Royal College of Surgeons' building facing the beautifully parked Lincoln's Inn Fields, appreciate the tremendous value of the vast material which has gradually accumulated in hall after hall. Revolting to physicians and humanitarians everywhere, has been the news of the destruction of much of this by Nazi bombing during the spring of 1941. In shattering the quiet old building where so much knowledge had been accumulated for the welfare of humanity everywhere, including the Nazis themselves, not only were the priceless collections of surgical instruments practically annihilated, but also whatever records there were available to describe them.

Fortunately, Dr. Thompson, as curator of the Royal College of Surgeons, had thoroughly studied this material and had prepared this com-

prehensive survey which Henry Schuman is now offering in so beautiful and appropriate a format. A portion of this material had appeared serially in the *British Journal of Surgery*. For purposes of presentation in book form, Dr. Thompson completed and rounded out the matter to the point where it constitutes a complete record of the famed Royal College Collections, now ruthlessly and irreplaceably damaged by Nazi barbarism. While this historical survey can never supplant the instruments themselves, it will serve to perpetuate the purpose of the collection, and to carry forward the humanitarian function of the Royal College of Surgeons in preserving the record of the developing technique of surgical art, so that all who appreciate it may profit from it. Doctor Thompson's book thus becomes another thrilling justification of the faith that no matter how powerful or insane the instruments of destruction may become, there is certain to remain an effective knowledge of the instruments of mercy and peace.

San Francisco, California
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CHAUNCEY D. LEAKE

The Contents

THE HISTORY AND EVOLUTION OF SURGICAL INSTRUMENTS

GENERAL OBSERVATIONS

In attempting to trace the origin of the more important instruments employed in surgery, we are led back to the palaeolithic period, when the stone knife, flaked-flint, and obsidian were the sole implements used for cutting or scraping, as instanced in the evidence of trepanning by primitive man from skulls of prehistoric times. Their use in other surgical operations, although suggested by instruments still employed by aboriginal tribes, must, however, be largely conjectural. We know that certain instruments were undoubtedly evolved from the tools used by the early craftsmen, such as the drill, the saw, and the wimble, but the cutting-knife or scalpel must have been employed in far earlier times and was probably the earliest instrument used by the surgeon.

Our chief sources of information respecting the shape and form of the instruments used in surgery in ancient times are the descriptions given by classical authors and representations in marble and stone, for it is not until the Roman period at the beginning of the Christian era that we have any actual specimens of the instruments employed by the surgeon.

In the Hippocratic writings, stress is laid on the importance of the instrument being adapted to the hand of the operator and the means he should use in order to acquire "dexterity and elegant manipulation."

Thus we are told, "The nails should be neither longer nor shorter than the points of the fingers and the surgeon should practise with the extremities of the fingers; the index finger being usually turned to the thumb; when using the entire hand it should be prone, and when both hands, they should be opposed to one another.

"It frequently promotes a dexterous use of the fingers when the space between them is large and when the thumb is opposed to the index. One

should practise all sorts of work with either of them and with both together (for they use both alike) endeavouring to do them well, elegantly, quickly, without trouble, and promptly." Thus says the Greek writer.

Lanfranc of Milan (d. 1315) the pupil of William de Saliceto who brought Italian surgery to France and flourished in the thirteenth century wrote, "A surgian must have handes wel shaped, long smale fyngres and his body not quakyng and all must be of subtle wit."

Heister, writing in the eighteenth century, remarks that "a surgeon's hand would be of little service to him if he was not supplied with a variety of instruments," and so in the course of time instruments of every shape and form have multiplied. Every surgeon knows when an instrument is best adapted to his hand, and thus we have come to the innumerable differences in the shape and form of blades and handles that have been devised by operators throughout the centuries.

II

THE SCALPEL

THE Greek word used by Galen and Aëtius to denote the instrument we now call the scalpel is σμίλη and by the Latin authors *scalpellus.* It is described as a small light knife used in operations. The earliest known representation of the instrument is on a sculptured ex-voto tablet of stone that was found on the site of the temple of Aesculapius on the Acropolis at Athens, and probably dates from about 300 B.C. *Fig.* 1 (2). It depicts a case of scalpels arranged blade and handle alternately. The curved blade of the third shown is similar in shape to some in use at the present day. The other two are what are alluded to by Hippocrates as the "bellied scalpel," used "to incise the outer integument between the ribs." Galen calls it the "bellied surgical knife," so termed from the Greek word meaning "like the breast of a woman." That scalpels with blades of this shape were introduced by the Greco-Roman surgeons into Egypt about 150 B.C. is evidenced by an incised stone tablet in the temple of Asklepios at Kôm-ombos on the Nile. *Fig.* 1 (1). On this interesting tablet we have also many representations of the instruments used in gynaecology by Greco-Roman surgeons in the second century before the Christian era.

It is probable that these instruments were made of steel, for long before the date of the earliest medical writings Greece had passed into the iron age, and by the time Hippocrates flourished the metal was in common use. The Greeks knew the process of tempering steel, and, there is little doubt, employed it for making their cutting instruments, such as the blades of knives made for surgical use. Galen remarks, in his time, "the best quality of steel yielded a knife which neither blunted easily nor bent or chipped."

It is notable that some instruments, like the scalpel, were made with

double ends with the handle in the centre, and so shaped to give a grip for the fingers, for, as Hippocrates observed, "All instruments ought to be well suited for the purpose in hand as regards their size, weight, and delicacy."

After the Hippocratic period there is a gap of centuries until we come to the Roman era. Here we are on surer ground, as fortunately owing to the material of which they made their surgical instruments we have many actual specimens still in existence. The Roman surgical instruments which have been discovered are mostly of bronze, and although iron and steel were also employed for blades, they have perished in the course of time, but the bronze has remained.

The ordinary scalpel used by Roman surgeons usually had a straight sharp-pointed blade with sometimes a curved cutting-edge. *Fig* 1 (3). The illustration represents one found among the surgical instruments discovered at Pompeii. Others were made with double ends, having a blade at one end and a leaf-shaped spatula at the other which could be used as a blunt dissector. The centre bar or handle was of bronze and was either round, square, or hexagonal in form. In the single scalpels and knives, the steel blade was fixed in the handle by a binding-thread or wire, and was detachable so as to allow it to be removed for cleaning. The blades were generally straight or curved, with sharp points, and sometimes had double cutting-edges.

From the specimens we have of Roman instruments it appears that, whenever possible, it was usual to combine two instruments in one. Thus we find many of the probes have a spatula at one end and a scoop or spoon at the other. The vulsellae sometimes have a scoop, probe, or raspatory at the opposite ends, giving the Roman surgeon two instruments in one. This custom of combination was carried on by instrument-makers until comparatively modern times.

The handles of some of the Roman instruments are often finely worked and occasionally damascened with silver; others show traces of having been gilded. Certain specimens which exhibit clever craftsman-

ship have a figure of a deity or the head of an animal as a terminal, and are real works of art.

It is notable that most of the Roman instruments were made entirely of metal and so could be easily cleaned by boiling in water, also that the blade and handle were at times connected by something like our aseptic joint.

Aulus Cornelius Celsus (25 B.C.-50 A.D.), in his important work on medicine, refers to the use of the scalpel for "dilating a wound to facilitate the removal of a weapon embedded in the flesh,"[1] and directs the operator to "make the incision sufficiently large so the weapon may be extracted."[2] He also recommends the employment of a scalpel when extracting a foreign body, such as a stone that has become embedded, so as to enable it to be extracted with a forceps. He tells us later, that

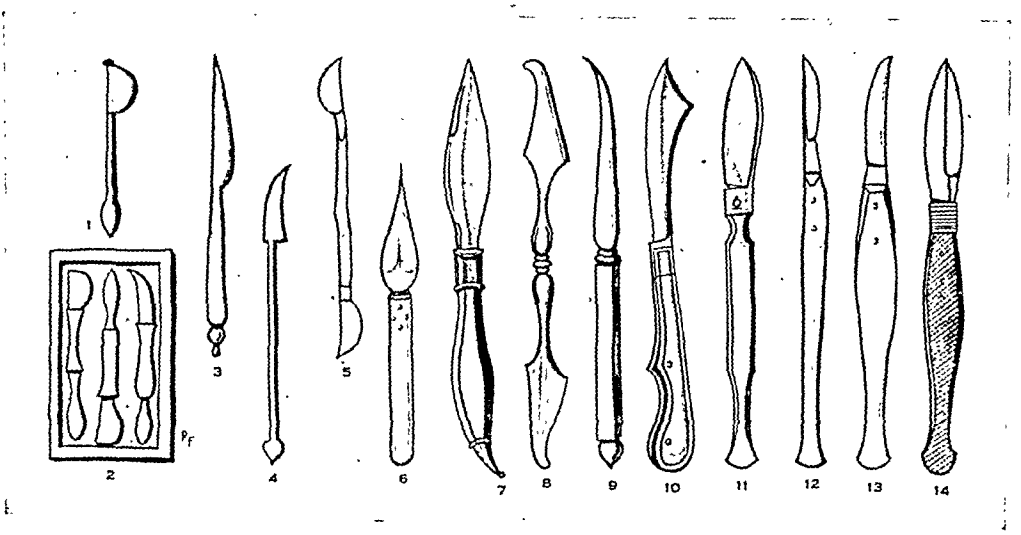

FIG. 1. Scalpels from 300 B.C. to the 19th century A.D. For details, *see* text.

1. Egyptian Scalpel, *c.* 150 B.C.
2. Case of Scalpels, Greece, *c.* 300 B.C.
3. Scalpel from Pompeii.
4. Albucasis, from the Bodleian MS., 1271.
5. Wryghtson MS., *c.* 1350.
6. Della Croce, 1598.
7. Guillemeau, 1598.
8. Garangeot, 17th century.
9. Fabricius ab Aquapendente, 17th century.
10. Heister, 1740.
11. Perret, 1772.
12. Sir William Fergusson.
13. Sir William Flower, 1861.
14. Late 18th century.

[1] CELSUS. Book VII, Cap. 5, Sec. 2.
[2] CELSUS, Book VII, Cap. 5, Sec. 6.

"Heraclides the Tarantine advises in an operation on the eye, following adhesion of the lids to the white of the eye, to effect a separation with the sharp edge of the scalpel, cutting very gently."

Isidore of Seville (A.D. 570-636) mentions several surgical instruments used in his time, but it is not until we come to the tenth century in the days of Albucasis or *Abu'l Kasim ben Abbas al-Zahrawi,* the Arabian surgeon, that we have fuller descriptions and figures of the instruments employed. There are a number of manuscripts of his work extant in Arabic, Persian, and Latin, the latter having been translated by Gerard of Cremona (A.D. 1114-1187). The drawings of the instruments illustrating the codices vary according to the style and period of the delineator, but probably the best in this country is the manuscript now in the Bodleian Library, dated A.D. 1271.[3] The drawings are made in black ink in realistic style, so we are able to judge of their detail. The scalpel depicted, *Fig.* 1 (4), reproduced from this manuscript, shows an instrument of metal with a small curved blade and a single inner cutting edge. The straight handle terminates with a leaf-shaped spatula. There is another manuscript of the work in the Bodleian of a later date[4] in which the drawings are outlined in red ink, but the manuscript with the most ornate illustrations in colour is that preserved in the British Museum, which will well repay study.[5]

Handles of wood and bone appear to have been introduced about the fourteenth century, and an example is depicted in the manuscript, believed to date from 1350, that belonged to John Wryghtson, now in the library of St. John's College, Oxford.[6] It contains fifty-four drawings of instruments used at the period, including a double-ended scalpel. *Fig.* 1 (5). The blades at either end are similar in shape, are curved on the cutting-edge, and have straight backs. They are secured to the flat handle (apparently of wood) by metal collars, and were probably removable.

In the sixteenth century the blades of scalpels became more leaf-shaped and had double cutting-edges. They were secured to the round handle of wood or bone by rivets, as shown in the drawing from Della Croce's *Cirurgia,* printed in 1598. *Fig.* 1 (6). In the same year, Guillemeau figures a scalpel with a similar type of blade, but narrower and slightly bevelled off near the point. It has an elaborate handle, slightly shaped to fit the hand, and has a decorated collar. The handle of wood is hexagonal in shape and is terminated with a sharp metal cap. *Fig.* 1 (7).

In the seventeenth century we have examples of the "all metal" instrument, as shown in the scalpel depicted by Garengeot. *Fig.* 1 (8). This, again, is a double-ended instrument of metal with curved blades turned at the ends. About the same period, Fabricius ab Aquapendente figures a long-bladed scalpel with an inside cutting-edge, sharp pointed and slightly curved at the apex. It has a square-shaped handle as long as the blade, terminating with an acorn-shaped knob. *Fig.* 1 (9).

A scalpel with a curiously shaped blade and handle is depicted by Heister in 1740. The scimitar-like blade has a single cutting-edge and has evidently a broad, flat back. The handle of bone is shaped to the hand to give a firm grip, and is rounded off at the end. *Fig.* 1 (10). Perret, in 1772, figures a scalpel with a leaf-shaped blade and straight single cutting-edge. It is riveted to a shaped bone handle, and is the first shown with a flattened terminal. *Fig.* 1 (11).

Towards the end of the century came handles of ivory or of chequered wood, with the object of giving a firmer grip and to prevent slipping. The blades were leaf-shaped with double cutting-edges and secured to the handles with a metal collar. The flat handles curved out and again inwards, and terminated in a spatula end. *Fig.* 1 (14).

The surgeons of the nineteenth century appear to have preferred much shorter blades, either straight or slightly curved. The thin, flat ivory handle came into vogue, as shown in the favourite scalpel used by Sir William Fergusson, now among the collection of instruments in the Museum at the Royal College of Surgeons. *Fig.* 1 (12). A scalpel of a

similar type, with a short, slightly curved blade and ivory handle, was used by Sir William Flower in 1861. *Fig.* 1 (13). It was not until the last half of the nineteenth century, after Lister's time, that a new era began in the materials used in the manufacture of all surgical instruments. For the purpose of sterilization, instruments made entirely of metal were once more necessary. Handles of ivory, bone, wood, and tortoise shell had to be discarded, and may now be regarded only as relics of a by-gone age.

II

THE AMPUTATION KNIFE

According to Aryan tradition, Sūsruta, a disciple of Dhanvantari the Hindu Father of Medicine, records in *Samhita,* his book on Surgery, said to have been written about 600 B.C., a hundred and twenty-one surgical instruments in a chapter he devotes to the preparation of a surgeon for accompanying the king to the battlefield. He enjoins that "the instruments should have good handles and firm joints, be well polished and sharp enough to divide hair. They must be kept perfectly clean and wrapped in flannel in a wooden box but the best and most important of all is the hand."[7] Amputation, he states, was done now and then, notwithstanding the want of good control over the haemorrhage. Boiling oil was applied to the stump by pressure by means of a cup-formed bandage; pitch being sometimes added.

There is a close correspondence between Sūsruta's writings and the Hippocratic collections, and some of the operations he describes agree with the accounts of Alexandrian practice and those given by Celsus.

It is not, however, until the first century of the Christian era that we have a description of the amputation of a limb. Aulus Cornelius Celsus, in his account of the operation, says: "When the malady gets the better of our medicines the limb must be amputated, but this is attended with great danger, for often during the operation itself the patients die from the haemorrhage or from deliquium. But in cases like this where we have but one remedy, expediency and not safety is the paramount consideration. We are therefore to make an incision with a knife between the sound and morbid parts down to the bone, with this qualification, that we are never to cut opposite a joint and always to include some of the sound part rather than leave any of that which is diseased. When we come to the bone, the sound flesh must be retracted so as in some

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[7] Jamini Bhushan Roy. *Report on Indigenous Systems of Medicine.* Part I. Madras. 1923.

measure to denude it; then it must be divided with the saw close up to the sound flesh. The end of the bone is then to be smoothed where the saw has left any asperity and the integuments brought over it, which, in this operation ought to be left loose enough to cover the entire stump or as far as possible. When the stump happens not to be covered with integument it must be dressed with lint and over that a sponge dipped in vinegar is to be secured by a bandage."[5]

The knife used by the Roman surgeon, judging from the specimen found among the surgical instruments discovered at Pompeii, was shaped like a large scalpel with a steel blade and bronze handle. *Fig.* 3 (1).

That stumps were sometimes fitted with artificial limbs is evidenced from the leg made of bronze plates fashioned to a wooden core. *Fig.* 2. This unique relic of orthopaedics, now in the Museum of the Royal College of Surgeons, was excavated from an undisturbed tomb near Capua. It was probably intended to replace the right leg, as the skeleton found with it had a waistband of sheet bronze edged with small rivets made to fasten to a leather lining. Two iron bars, having holes at the free ends, are attached to the extremity of the bronze, and a quadrilateral piece of iron found near the position of the foot was probably fixed to the leg below so as to strengthen it.

Among the leading surgeons of the first century was Heliodorus (ca. A.D. 75), who was contemporary with Juvenal. On amputation he observes: "In sawing the bone the plate of the saw ought to be applied even, in order that the sawing of the bones be even. When the bones are sawn, cut through the other parts with a scalpel." This clearly shows that the Greek surgeons employed a large scalpel for making the incision.

Archigenes of Apameia (A.D. 48-117), who lived in Rome under the Emperor Trajan and operated for cancer of the breast and ligatured bleeding vessels, described both the circular and flap amputation. With respect to the latter operation he says: "After cutting down to the bone the tendons are to be retracted and the bone scraped and sawn."

Both these surgeons employed ligatures, which, we are told, in Galen's time were "to be bought at a shop in the Via Sacra."

Galen (A.D. 130-200?) himself recommends amputation to be performed in general at a joint in certain cases of gangrene.[9]

Coming to the seventh century, Paulus Aegineta (A.D. 625-690), who

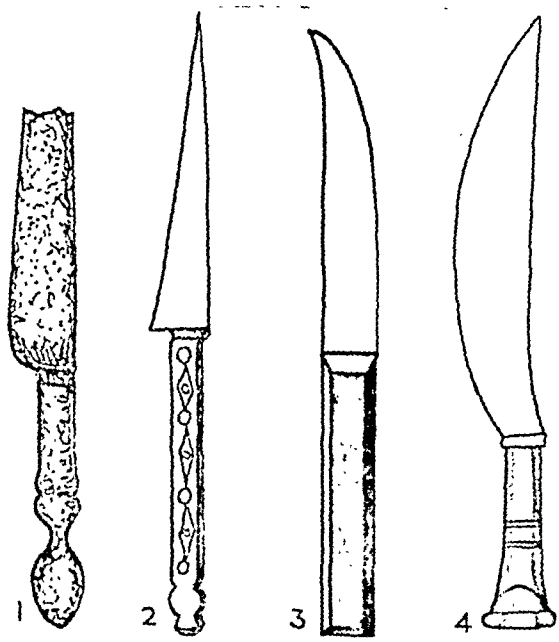


FIG. 3.—Amputation knives: 1. Roman; 2, Albucasis; 3. Wryghtson. 1350; 4. Knife of the fifteenth century.

[9] *Galeni Commentar. De Articulis*, Basle T.V., p. 650.

alludes to amputation in his works, says: "Saw the bone as expeditiously as possible, applying a linen rag to the parts which have been cut lest they be torn by the sawing and occasion pain. Then having cut through what remains, apply the red-hot irons and stop the haemorrhage thereby with compression."[10]

The Arabian School performed amputations as early as the tenth century and also practised excisions of the bones and joints. Rhazes (850-923 A.D.) observes, on the sawing of bones, that the flesh upward and downward should be stretched with a piece of cloth so that it may not come in the way of the back of the saw. He recommended that when the bone was diseased, the whole diseased portion should be cut out.

Among the instruments depicted in the illustrated manuscripts of Albucasis (A.D. 936-1019) is a knife with a straight blade, wide at the base and narrowing to a sharp point, which he calls a "knife-razor." *Fig.* 3 (2). In the account he gives of amputations it is directed that the fleshy parts are to be divided with a large scalpel down to the bone, which afterwards is to be sawed across.

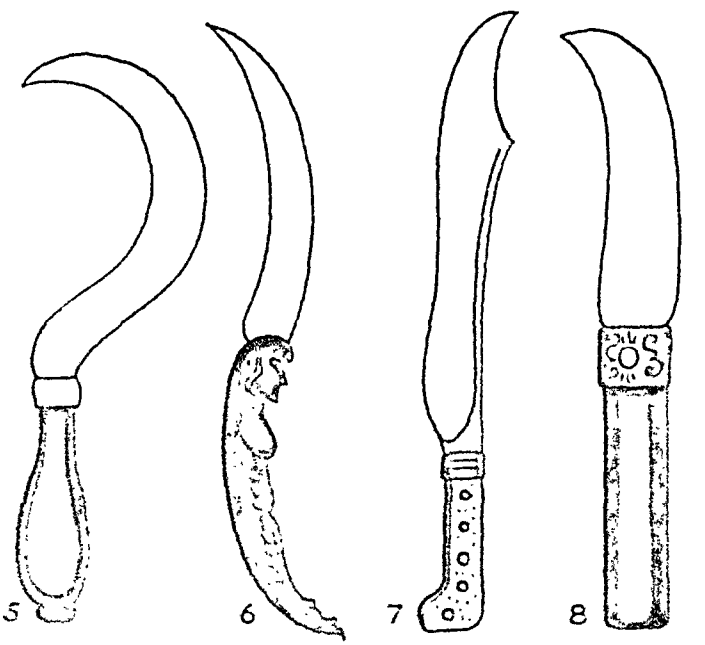


FIG. 4.—Amputation knives: 5, Paré's crooked knife; 6, Paré's straight knife; 7, Vesalius, c. 1550; 8, Guillemeau, 1594.

[10] *Works of Ambroise Ambroise*, Vol. II, p. 401

Guy de Chauliac (A.D. 1298-1368), the famous author of *Chirurgia Magna,* which for centuries influenced the practice of surgery in Europe, followed the Arabian School in his methods of operating. He classified haemorrhage as arterial and venous, and employed styptics, sutures, the actual cautery, and ligation.

In the manuscript work on Surgery that belonged to John Wryghtson of Oxford in 1350, the amputation knife depicted has a short blade which is curved slightly inward at the extremity. *Fig.* 3 (3). But a century later, the shape of the blade was completely changed, and it was curved backward with the cutting edge on the outside, as shown in the illustration. *Fig.* 3 (4).

Ambroise Paré (1509-1590) the great French military surgeon, who gained much of his experience of amputations on the battlefields, describes in his *Chirurgie* two knives that he used when operating. One he calls an incision knife and the other a "crooked knife for dismembering," the blade of which is crescent-shaped with the cutting edge on the inside. He remarks, "when you have made your ligature, cut the flesh

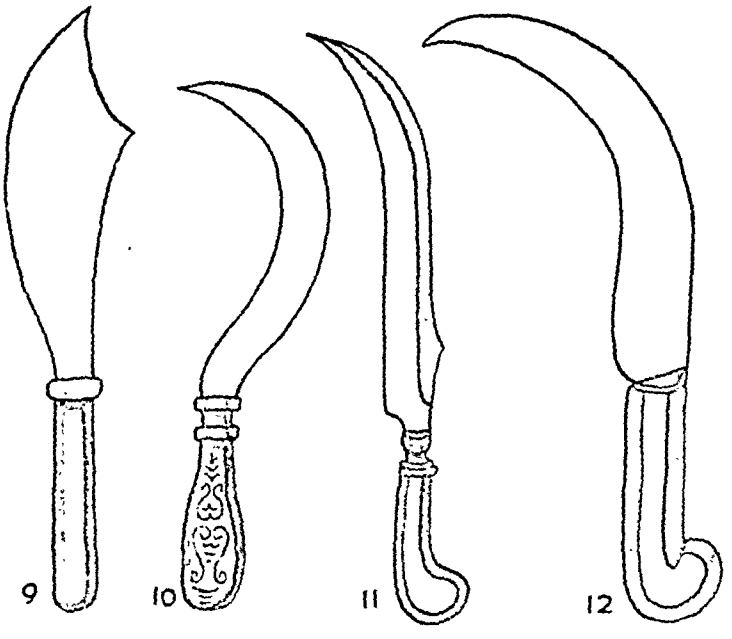
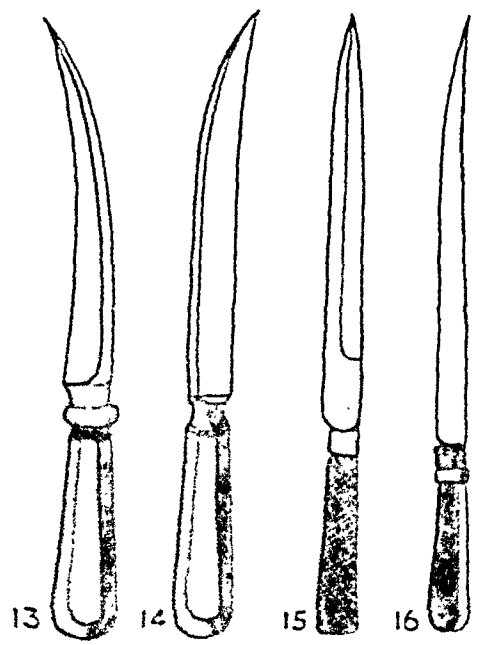


FIG. 5.—Amputation knives: 9, Hildanus, 1646; 10, Scultetus, 1665; 11, Sharp's curved knife, *c.* 1739; 12, Perret, 1772.

even to the bone with the sharp, well-cutting incision knife or with a crooked knife." *Fig.* 4 (5, 6).

Among the instruments figured in the works of Andreas Vesalius (1515-1564) is an amputation knife with a large blade slightly curved part way at the back and with an almost straight cutting edge which is rounded off at the point. *Fig.* 4 (7). The wooden handle is decorated and terminates in a knob curving inwards to give firmness to the grip. In 1594, Guillemeau figured another type with a broad blade curved only at the extremity, *Fig.* 4 (8); but fifty-two years later, Fabricius Hildanus describes a new-shaped blade which differs widely from its predecessors. *Fig.* 5, (9). Shaped like a scimitar, it has the cutting edge on the outside of the curve of the heavy blade, while the back is bevelled and sharp. The handle of lignum vitae is highly turned and finished.

But this innovation did not last long, judging from the *Armamentarium Chirurgicum* of Scultetus (1663), for he reverts to the earlier type, and calls his instrument a "crooked knife wherewith the flesh is cut in so far as the bone which must be saw'd off and is necessary before the amputation of the leg or arm." *Fig.* 5 (10).



During the first half of the eighteenth century several important changes took place in the shape of blades. About 1739 Sharp introduced his strongly curved blade which sometimes had a double edge, *Fig.* 5 (11), and later Perret favoured a still more crescent-shaped knife with a periosteal elevator which was used in France until late in the century for the amputation of the arm and lower extremity below the knee. *Fig.* 5 (12).

From 1760 to 1780 the curved

blade of varying shape was in general use, and so remained until eight years later, when Loder advocated a knife with an almost straight edge which he found to be effective. *Fig.* 6 (13).

Then came a period of transition during which the straight-bladed knife began to replace the strongly-curved type used by Sharp and other surgeons in the earlier part of the century. Benjamin Bell figures a straight knife in his *System of Surgery* in 1788, and Savigny ten years later illustrates a knife with a blade intermediate between Bell's and Perret's, and points out that "care should be taken in the construction of this instrument that the back is not thicker than is absolutely necessary to give and support the required firmness of edge, otherwise it becomes unwieldy in its management." *Fig.* 6 (14). Sir Astley Cooper, however, preferred the broad back for his amputating knife, which is in a case of his instruments now preserved in the collection in the Museum of the Royal College of Surgeons. It has a very thick back with the sides of the blade much smoothed along its borders, but the blade is straight, slightly curving to a blunt point. A marked flattening of the blade on each side of the back is characteristic of this pattern. The ivory handle which came into vogue about this time is smoothly chequered, but most of the handles of the period are made of lignum vitae and shaped octagonally with the terminal either curved inwards or outwards.

Lisfranc, who preferred straight-bladed knives for amputation, observes that "when a knife is required for the forearm or leg, the cutting edges should be extended to the insertion of the blade into the handle." He therefore had his knives made with long, slender blades with double edges. *Fig.* 6 (15).

Thus, about the mid-nineteenth century, the fashion of the long straight blade came into favour and its use was established by Robert Liston in 1846. The skill and rapidity with which this brilliant surgeon performed his operations is well illustrated in the story of the historic occasion when he amputated the thigh of a man at University College Hospital on December 21, 1846. The patient had been placed under ether for the first time in this country. He had been successfully anaes-

thetized, and Liston, having selected one of his favourite long, straight knives, turned to the students and others who crowded the theatre saying, "Now gentlemen, time me." The operation was completed.

"Twenty-eight seconds," exclaimed Squire, who stood watch in hand.

"Twenty-seven," cried Bucknell.

"Twenty-six," said Russell Reynolds.

"Twenty-five," quietly remarked Edward Palmer, Liston's dresser, and the surgeon smiled in reply."

Some of the knives Liston employed had blades over a foot long which finished with a dagger point, the backs being sharpened for the last two inches. The cutting edges were almost straight till they curved upwards near the free ends to meet the backs. *Fig.* 6 (16). He thus explains his reasons for favouring the long, slender blade in his *Practical Surgery:*[12] "The form and size of the instrument ought always to be in proportion to the extent of the proposed excision as regards both their length and depth. Nothing can possibly be imagined more abominably cruel, for instance, than the attempt (which has to my knowledge been repeatedly made and which I have in fact witnessed) to remove the lower extremity of a full-grown person with a common scalpel or dissecting knife. If an extensive incision is necessary, an instrument possessing sufficient length of edge must be employed so that the parts may be separated smoothly and quickly."

Liston insisted that the handle of a surgical knife should be perfectly smooth and polished, as in fact, he observes, ought to be the handles of all instruments in the use of which delicacy of touch is necessary. "Some practitioners," he continues, "have carried fashion so far, that many even of the catheters and sounds are to be found fitted with wooden handles, deeply grooved and chequered. The inventors of these seem to have been more afraid of losing hold of the instrument in a fit of agitation and panic than intent upon fitting it for its legitimate purpose and using it in a proper and workmanlike manner."

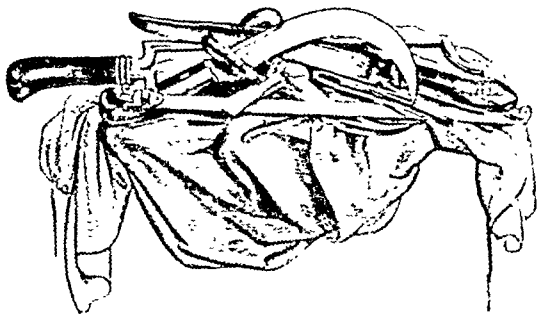
[11] C. J. S. Thompson, *Lister*, 1934, p. 15. John Bale and Danielson

[12] Robert Liston, *Practical Surgery*, 4th edition 1846.

The Amputation Knife

A pair of Liston's amputating knives that belonged to Syme of Edinburgh are now in the "Lister Collection" in the Museum of the Royal College of Surgeons. The blades are fourteen and a half inches long and an inch and a quarter deep.

The trophy of instruments reproduced below from Liston's work is said to represent the amputating knives which he held to be obsolete.



· III ·

THE SAW

THERE is evidence from specimens which have been excavated in various parts of the world that the saw has been known to man from the neolithic period. The idea of the toothed implement for cutting bone or wood may have been suggested to him from such natural objects as the sawfish with its sharp projections or the finely serrated tooth of the shark, which is believed to have been used for cutting bone from prehistoric times.

Pliny ascribes the origin of the saw to Daedalus or his nephew Perdix, who was supposed to have conceived the idea from the jaw of a serpent with which he found he was able to cut a piece of wood. But whether there is any truth in this mythological story or not, saws with blades of finely flaked flint with serrated edges have been discovered in the lake dwellings in Switzerland and also in Egypt, dating from at least 2700 B.C. A specimen mounted in wood with a handle, now in the British Museum, *Fig.* 7, is said to be of the pre-dynastic period, and shows the tool as used by the Egyptians over 4000 years ago. The flint blade was superseded by metal in later times, and the saw represented in a painting at Thebes about 1500 B.C., shows the Egyptian carpenter using a tool similar in shape to that employed to-day. *Fig.* 8.

In ancient Greece, saw-blades of copper were first used, but they were succeeded by bronze, which was found to be harder and more durable.

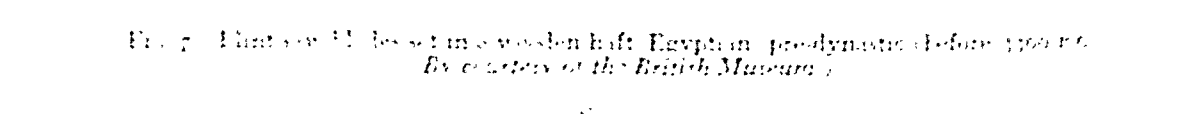


FIG. 7. Flint saw with bone and wooden haft. Egyptian, pre-dynastic (before 4500 B.C.). *By courtesy of the British Museum.*

It is not, however, until we come to the Roman period, a century or two before the Christian era, that we find blades of iron and steel. The saws used by the Romans were chiefly of the tenon type, *Fig.* 9, but that they also employed the bow or frame pattern is evidenced from a carving on stone, now in the Musée du Capitole at Rome, representing instruments used in sacrificial rites. *Fig.* 10.

Allusions to the use of the saw for surgical purposes are made by several of the classical writers, and among others by Celsus in his description of the amputation of a gangrenous limb, in which he says, "it must be divided with the saw close up to the sound flesh; the end of the bone is next to be smoothed where the saw has left any asperity."[12]

Mention is made of a knife-shaped or sword saw by Galen, which he describes as having a narrow blade continuous with the handle, like a knife, but such saws could only have been used for minor operations. Vido Vidius mentions similar instruments in the sixteenth century.

Paul of Aegina alludes to the surgical saw in the seventh century, and

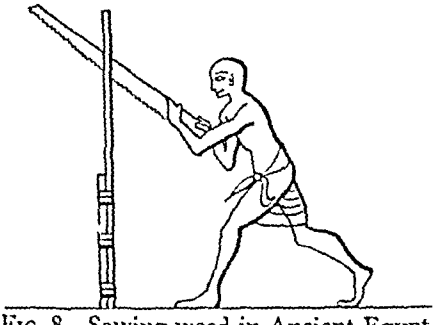


Fig. 8.—Sawing wood in Ancient Egypt. *(From a wall-painting at Thebes.)*

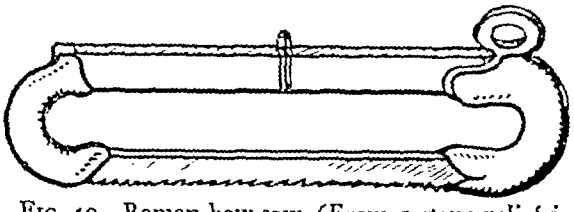


Fig. 10.—Roman bow-saw. *(From a stone relief in the Musée du Capitole, Rome.)*

Fig. 9.—Fine-toothed, bronze surgical saw, Roman. *(By courtesy of the British Museum.)*

[12] Celsus, Book VII, Cap. 33.

the small saws used in cranial operations probably date from about this period.

From Albucasis and the drawings illustrating the codices of his works of the twelfth and thirteenth centuries in the Bodleian Library and the British Museum we learn much about the development of the saw. Several types are depicted which show that the bow as well as the tenon saw was employed by the Arab surgeons. *Fig.* 11. One represented in the manuscript in the British Museum is interesting, as it shows the cutting blade strengthened and stiffened by plates connected with the rigid back.

A small cranial saw with a crescent-shaped blade fixed to a long straight handle is also depicted, similar to the drawing illustrating Wryghtson's manuscript in St. John's Library, Oxford. Wryghtson's larger saw, *Fig.* 12 (1), has an angular prow and is of the bow pattern similar to that used by Vesalius in the sixteenth century. *Fig.* 12 (2). In the sixteenth century, the Italian and French craftsmen, influenced by the art of the period, began to give more attention to the mounting of the saws used by the surgeons. They enriched the backs with scrolls

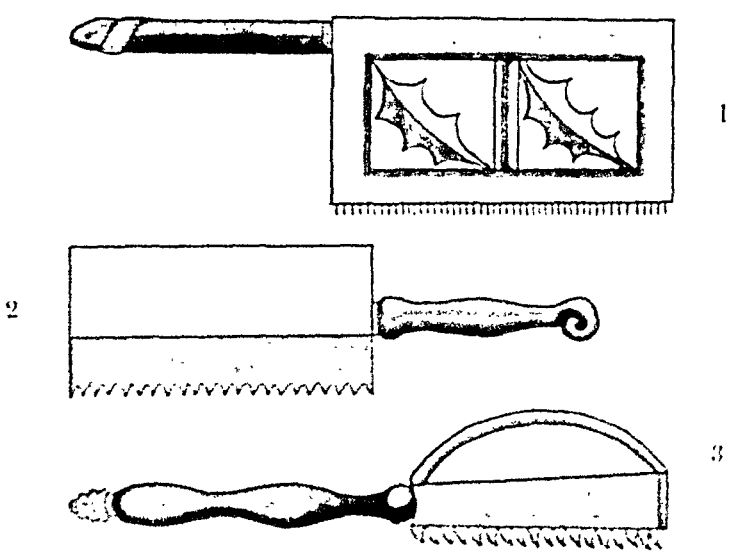


FIG. 11.—Surgical saws: 1, Twelfth century, *Albucasis Chirurgia* (B.M. Add. MSS. 36617); 2 and 3, Thirteenth century, Albucasis Arab MS., Marsh 54, Oxford.

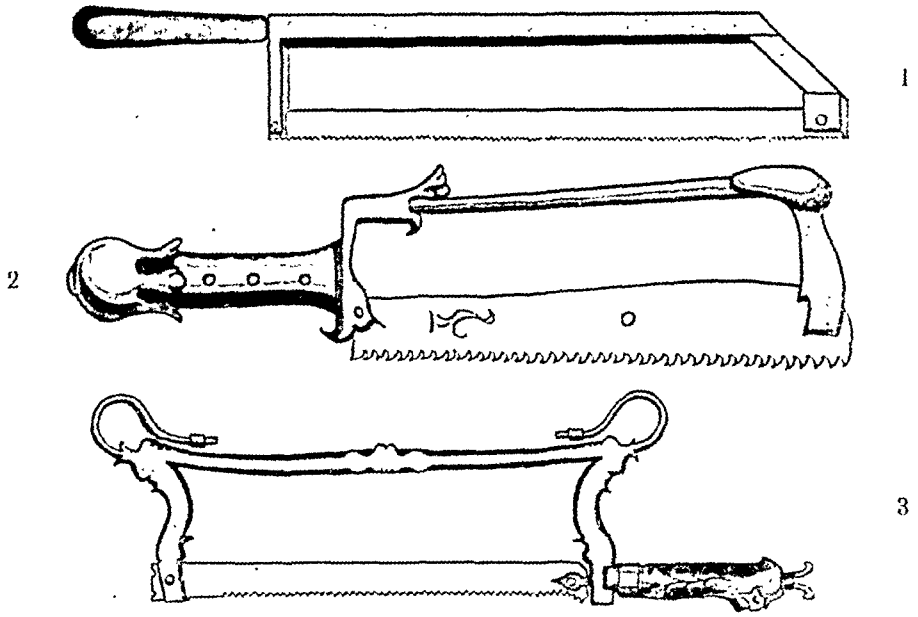


Fig. 12.—Surgical saws: 1, John Wryghtson, 1350; 2, Vesalius (sixteenth century); 3, Gersdorff (sixteenth century).

and ornamental work, and fitted them with carved handles of ebony or rosewood, as shown in the saw depicted by Gersdorff and Ryff. *Figs.* 12 (3), 13.

Hans von Gersdorff, who was a German army surgeon and an experienced and successful operator, flourished about 1500. He wrote a book on military surgery in 1517, in which he describes how, after amputation, he applied a bandage without sutures and checked haemorrhage by a caustic plaster. His saw had a removable blade fixed by a screw and hooks at each end of the frame to enable it to be hung on a wall or the pole

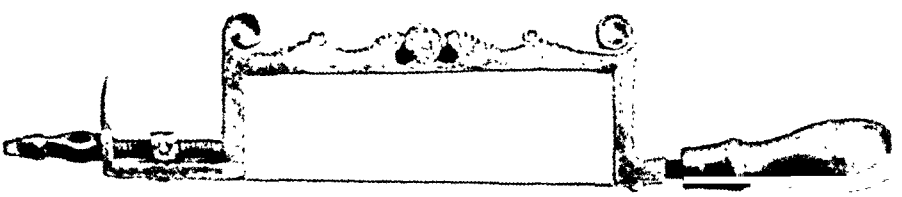


Fig. 13.—Ryff's surgical saw (sixteenth century).

of a tent. Walther Hermann Ryff was a surgeon of Strasbourg and author of many books on surgery and obstetrics, which were printed in Strasbourg and Frankfurt in 1541-5. His saw, represented with an ornamented frame, is the first depicted with a screw device to tighten the blade when necessary. *Fig.* 13.

The saw represented among the instruments used by Vesalius, about 1550, is of a more solid type and has a removable blade with coarser teeth. *Fig.* 12 (2).

In the mid-seventeenth century, Scultetus depicted a heavy saw with a thumbscrew device which passed through the handle in order to tighten up the blade when it became loose. *Fig.* 14 (1). Perret adopted this idea in his saw, which he described in 1779. *Fig.* 14 (2). Meanwhile, Sharp had described his saw, which had a deep blade and was also fitted with a tightening screw, and stated that the whole instrument with the handle should measure about seventeen inches. The handle was shaped, and had a hole for the finger.

During the eighteenth century, which was a period when many innovations were introduced in the style of the saw, several new types were devised. Among them was the guarded amputation saw, which was designed to cut the bone without injury to the soft parts. It consisted of a

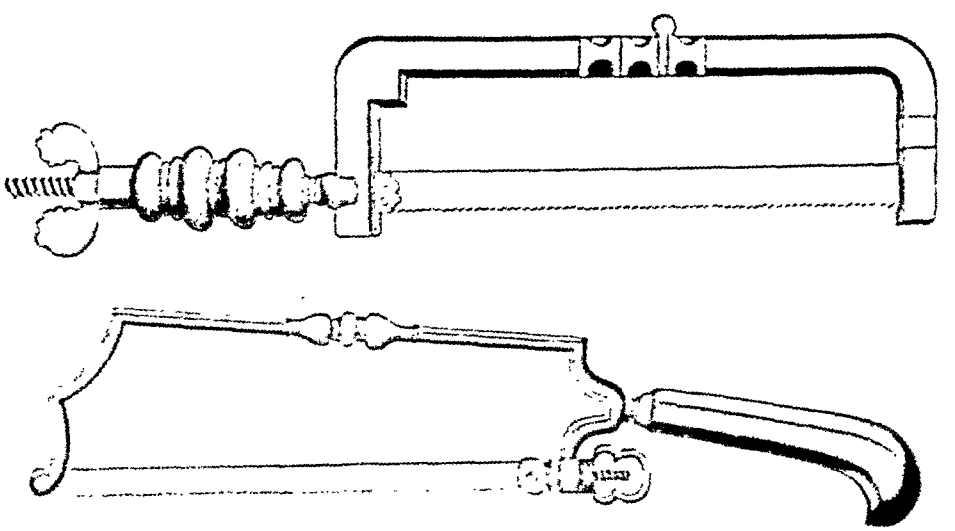


Fig. 14 – Surgical saws. 1. Scultetus (seventeenth century). 2. Perret (eighteenth century).

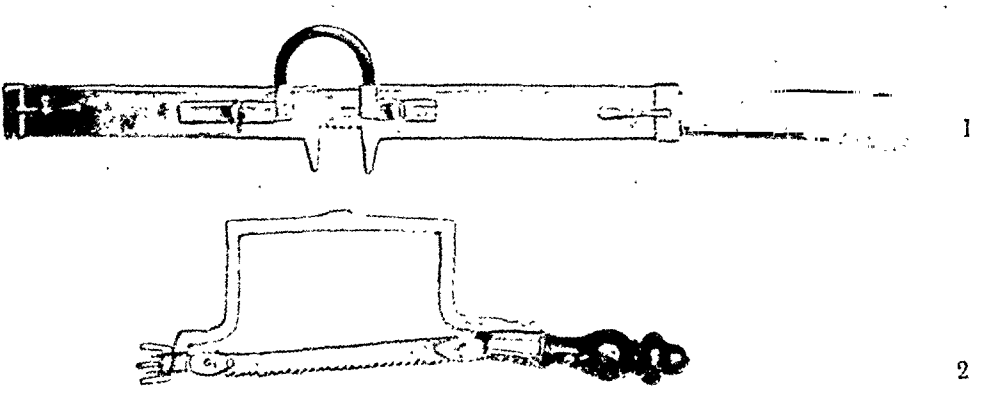


Fig. 15.—1. Guarded amputation saw for cutting the bone without injuring the soft parts (eighteenth century); 2, La Faye's bow-saw (*c.* 1740).

flat metal bar enclosed in a sheath with a sawing edge seven inches long. It had a bow-shaped clip which prevented complete closure of the two halves of the sheath, so that the sawing edge was constantly exposed. The inventor of this ingenious instrument, a specimen of which is to be seen in the Museum at the Royal College of Surgeons, is unknown. *Fig.* 15 (1). Later on, Charles Griffiths, of Edinburgh, introduced a circular amputation saw which was operated by a coiled spring. The instrument consists of a circular saw with large teeth working with geared cogs on the spring. A key winding the spring brings a toothed-wheel on to a spring pawl which is fixed to the larger cog-wheel that drives a smaller cog-wheel attached to the spindle of the saw. It has a strong handle of turned rose-wood with a steel finger-guard, but the whole instrument is very heavy and was certainly one which would have required great skill to manipulate. This brought other types of circular saws, the mechanism of which was even more complicated, so it is little wonder they never came into general use.

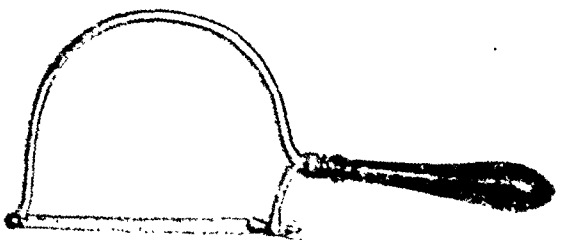


Fig. 16.—Benjamin Bell's bow metacarpal saw (1750).

In 1740, La Faye introduced a small saw of the bow type with a remov-

able blade which could be tightened by a screw at the end of the frame, *Fig.* 15 (2), which may be regarded as a forerunner of the metacarpal saw designed by Benjamin Bell. *Fig.* 16.

About the middle of the eighteenth century a change was made in the form of the saw. The bow or frame shape gave place to the tenon blade, and so in the nineteenth century the name amputation saw became identified with an instrument having a straight back and deep solid blade, like the carpenter's tool. Assalini commented on its advantages and it became the favourite-shaped saw of Percival Pott, and later was preferred by Fergusson and Lister. Savigny figured an example of this type in 1798, and remarks: "it is the saw now in universal use and is distinguished by the neatness of its construction and facilitation of its management from that formerly made with a frame or bow, and by its appellation 'Potts' from the preference constantly bestowed upon it by that very celebrated operator."

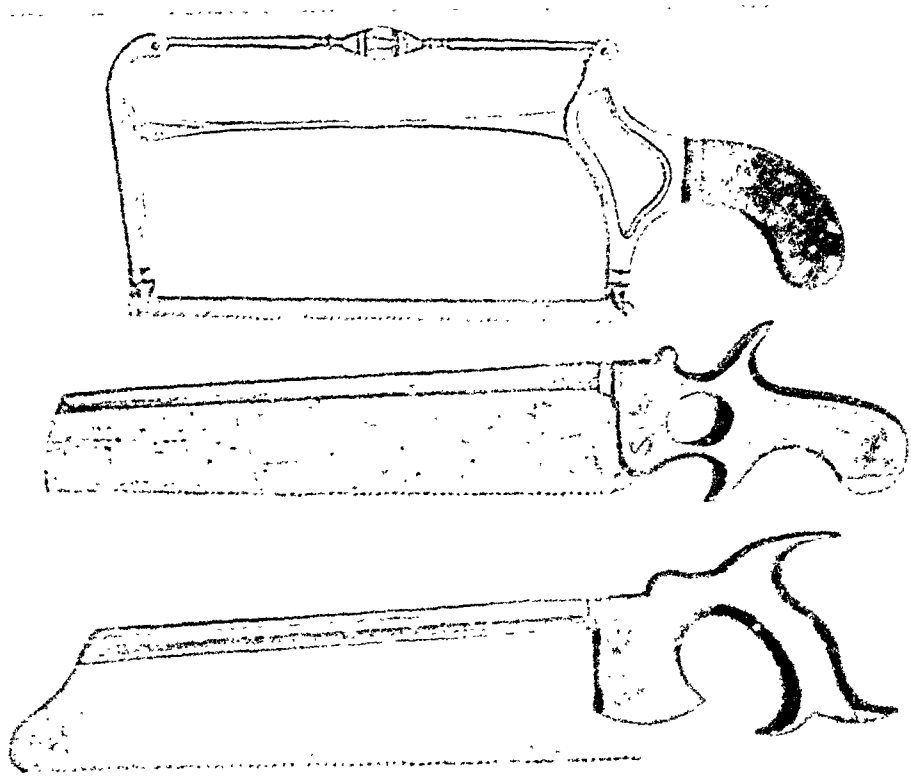


Fig. 17.—1, Butcher's saw. 2, Tenon saw used by an army surgeon on the field of Waterloo. 3, Tenon saw used by Fergusson and Lister (nineteenth century).

But this did not entirely extinguish the bow saw, for in 1851 Richard G. H. Butcher introduced a modification for which he claimed many advantages. In the account of the saw which still bears his name, after describing an amputation below the knee, Butcher states: "the saw which I have used in this operation and which I must strongly recommend now for the first time, is a modification of the bow saw used by cabinet-makers for cutting out fine work when curves are to be executed. The upright pieces are six inches high, half-an-inch wide and two lines thick; the one remote from the handle is received into the transverse bar and is movable. The depth of the blade is three lines (¼ inch), with the teeth well set off from each other and inclined forwards. The length of the blade is six inches, with the sockets included eight and a half inches. The middle bar is half-an-inch deep and two lines thick, while the upper bar is rounded with a screw at one end."

Butcher claimed that his saw possessed two good qualities—viz., that it readily cut in a curve, and from its slender proportions it could be easily slipped under the flaps and used without bruising them or catching in the retractor. *Fig.* 17 (1).

Sir William Fergusson's ideal amputation saw was one with a blade about nine inches long and two and a half inches deep. He favoured a handle of ebony similar in shape to that used by the cabinet-maker, and of such a size that whilst held in the palm it could be firmly grasped by three fingers, the forefinger and thumb being placed parallel with its upper margin to aid in keeping it steady. "The blade," he says, "should be sufficiently firm not to bend on the application of moderate force. The teeth well set out as to make such a breadth of groove as will allow the blade to move in it with facility." *Fig.* 17 (3).

An amputation saw of the army type, and which was actually used on the field of Waterloo, is depicted in *Fig.* 17 (2).

In 1870, Weiss introduced a saw with a slotted blade, which was said to prevent the teeth from becoming clogged, but it never came into favour, and subsequent years saw little change. During the present century, several types of minor saws have been devised, such as those sug-

gested by Adams and Annabel, while Heath advocated a saw with a very deep blade; but no radical change has been made in the saw used in amputations, and it still remains very similar in shape to the tool employed in ancient times.

Fig. 18, taken from a woodcut, 1528, shows an amputation in progress in that period. The saw depicted is similar in shape to that used by Wryghtson. *Fig.* 12 (1).

Fig. 18.—An amputation in progress.
(From a woodcut, 1528).

· IV ·

THE TREPAN

TREPANNING is one of the earliest surgical operations known, and there is ample evidence to show that it was practised by primitive man in prehistoric times. The scraping of a hole in the cranium at that remote period was probably carried out with the object of relieving pains in the head or epilepsy, and at the same time providing an exit for the disease demon or evil spirit and to allow its escape. *Fig.* 19.

The operation is still practised among the primitive tribes of New England and New Ireland, and in some parts of northern Africa, while it was formerly common among the Bushmen of Australia. It was usually carried out by scraping an aperture of varying size with a sharp piece of flint or obsidian, after which a bandage of banana fibre was applied over the seat of the operation.

In the western hemisphere, trepanning was practised at an early period by the ancient Incas of Peru, who performed it with great dexterity.

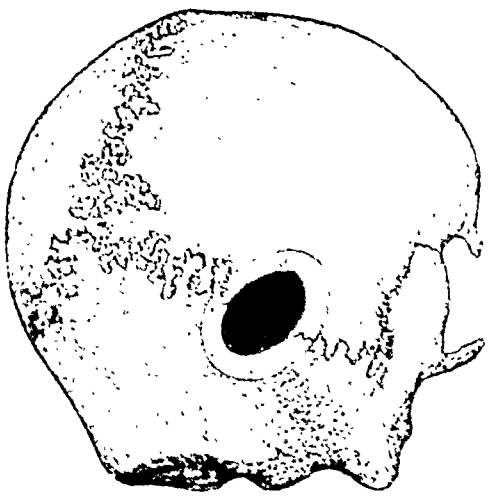


FIG. 19.—Prehistoric trepanned skull of the neolithic period. *(From "Mémoire de Joseph de Baye.")*

FIG. 20.—Ancient trepanned Peruvian skull. *(From "Mémoire de MacGee".)*

It is said that from 5 to 6 per cent of the ancient skulls excavated in Peru show that trepanning was resorted to, not only for therapeutic reasons to alleviate the effects of injury or cure disease, but also to obtain amulets to be worn as charms or to let evil spirits out or to allow good ones to come in. The Incas preferred square openings, and the operation is still practised by native medicine men among some tribes in South America in much the same manner as it was carried out in ancient times. *Fig.* 20.* The patient's head was held tightly between the surgeon's knees—the former reclining and the latter sitting. An incision was then made in the scalp and a section of bone, approximately an inch square, removed from the skull. The instrument employed was a sharp piece of flint or hardened copper with a rough edge, which was used by rubbing the edge backwards and forwards along the bone. *Fig.* 21. Sudden penetration was prevented by the increasing thickness of the instrument away from its cutting edge. Four grooves were made crossing each other at right angles, and, when they were sufficiently deep, the resulting square of bone was prized out of its bed. Sometimes the aperture was closed with

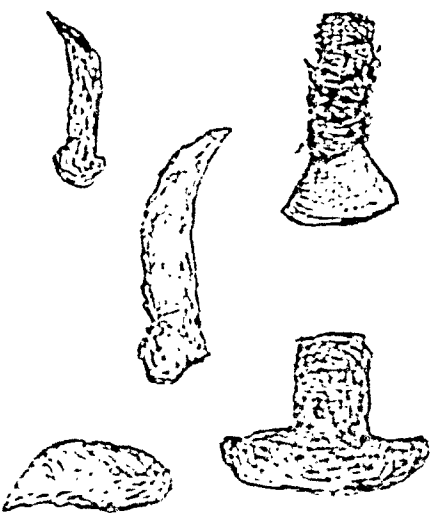


FIG. 21.—Stone and copper instruments used by the ancient Incas in trepanning operations

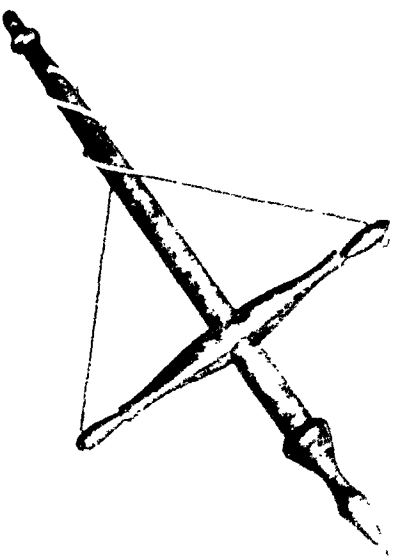


FIG. 22.—The *terebra* used by the early Greek surgeons.

* Skulls trepanned in a manner similar to that employed by the ancient Incas have recently been excavated at Lachish in Palestine. They are said to date from about 700 B.C.

a plate made from shell or other substance, although cases hav found in which the trepan opening was filled with a perfectly diaphragm of lead.

The round trepan openings found in ancient skulls in other p the world were usually made by drilling a number of small hol circle, or by cutting a circular groove round the piece of bone removed, and then breaking down the intervening portions; or i cases simply by scraping the bone with a piece of flint or stone.

In western civilization we find that trepanning was practised in the time of Hippocrates (460-377), and later during the per Celsus, Galen, and others. The instruments employed by the early surgeons varied, and included the *terebra* or drill, chiefly used fo ing the circle of holes round the depressed bone, which was opera a thong round the centre or on a cross beam. *Fig.* 22. For the sam pose, the trepanon, operated by a bow like a drill, was sometim ployed to make the perforations, and the interspaces between eac were broken up by the scalpel or lenticular so that the roundel o could be removed. Another instrument was the *prion charactos* o

Fig 23 – Trepanning operation upon the skull, from an Oxford manuscript

bra serrata, which consisted of a conical piece of metal with a circular serrated edge and a centre pin. It had a cylindrical handle several inches long, which was operated by rapidly rolling it between the palms of the hands. This was a prototype of the modern trephine. *Fig.* 23.

Celsus describes the operation and the instruments used by the Roman surgeons in the first century of the Christian era. He tells us that the trepan was "a round hollow instrument with a serrated edge furnished at its centre with a pin which was also surrounded by an interior circle." Of the *terebra,* or wimble, he states, "there are two sorts; one is like that used by a carpenter, the other having a larger blade which begins with a sharp point, then suddenly becomes broader, and above that part again insensibly narrow all the way up. If the disease is confined to a space which might be covered by the trepan or *modiolus, Fig.* 24 (1), that instrument is to be preferred. If it be caries, the centre pin of the instrument must be pushed into the opening; if blackness, a small depression must be made with the angle of the chisel to receive the pin, so that the trepan may not slip while we are turning it round. It is to be rotated like a wimble, by means of a strap. The pressure must be so regulated that the instrument may perforate and yet be turned round."

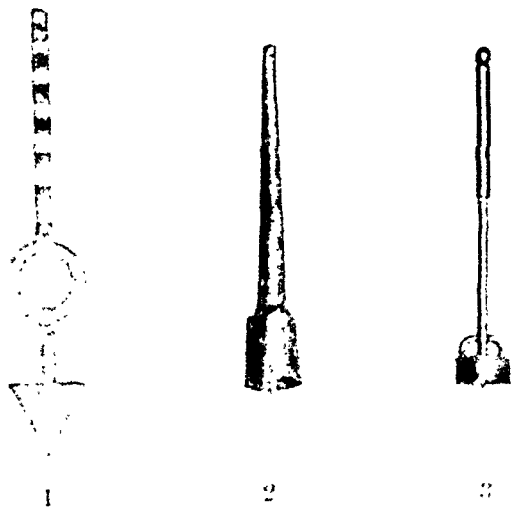


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Fig. 24.—1. The spear-headed *trefforia* employed by Arab surgeons, and described by Albucasis; 2. The *modiolus* described by Celsus; 3. A trepan similar to the *modiolus*, depicted by Wyeglet in 1539.

He then tells us how the Roman surgeon solved the problem of the centre pin, which is necessary until the toothed portion had begun to bite. "When the trepan has made for itself a channel," he says, "the centre pin must be removed and the instrument worked by itself; then when by the appearance of the dust we recognize sound bone, the trepan must be withdrawn. If the wimble be used,

here too the dust indicates to us how far the wimble ought to penetrate. In whichever way the circle has been made, with the chisel laid flat with the corrupted bone, each superior lamine must be shaved off till nothing but sound bone be left."

He further describes another kind of *terebra,* consisting of a strong copper plate slightly curved backwards and polished on its outward surface: "with this surface next the brain it is from time to time put under that part which is to be removed by the chisel, and if it encounters its edge it arrests its further progress."

"Wool steeped in oil and vinegar was applied as a dressing, and in process of time flesh grows from the bone itself and fills up the cavity left after the operation."

In the twelfth century the Arab surgeons were practising trepanning, and we learn from Albucasis that they employed a borer with a sharp point and an instrument terminating with a spear-like head called an *incisoria,* for drilling the holes round the piece of bone to be removed as already described. *Fig.* 24 (1). Lanfranc, of Milan, who wrote at the close of the thirteenth century, alludes to "a trepane wich the brayn scalle schal be trepaned with." John Wryghtson, in 1350, depicts an instrument similar in every way to the Roman *modiolus,* which was operated by rolling the shaft between the palms of the hands. *Fig.* 24 (3). In the

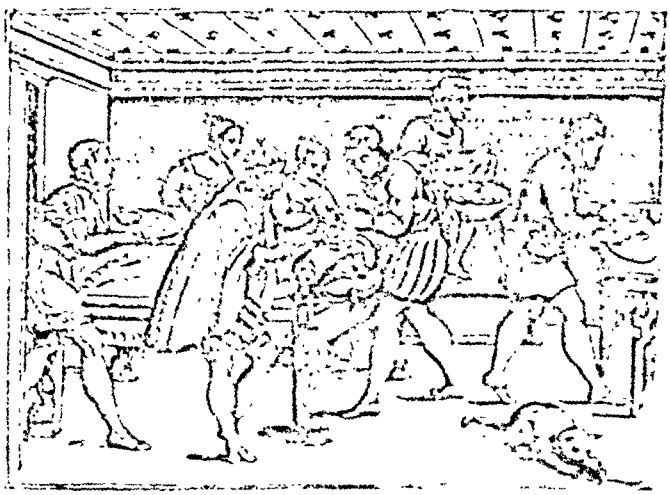


Fig. 25.—A trepanning operation in progress. Antiq. della Croce, 1572.

fifteenth century, Jerome Brunswyke describes instruments he calls "treppanes," terminating with a long gimlet-like screw, for making small holes in the skull.

When Andrea della Croce began to teach in Venice about 1560, he employed several types of instruments for trepanning, which, judging from the illustrations in his works, was an operation commonly practised at the time. He used a brace and drill stock, to which the circular saw or a sharp perforator was fixed with a screw. *Fig.* 25.

The first innovation in the trepan was introduced towards the end of the century, when, in 1575, Matthia Narvatio, of Antwerp, invented a mechanical instrument which was operated by a cog-wheel turned by the hand. This was connected with another wheel which, when rotated, actuated a circular saw which cut into the bone, but the instrument was so clumsy it does not appear to have come into general use. *Fig.* 26.

To Fabricius ab Aquapendente (1537-1619) is attributed the invention of the trephine, so-called from its triangular shape.[15] Savigny, in com-

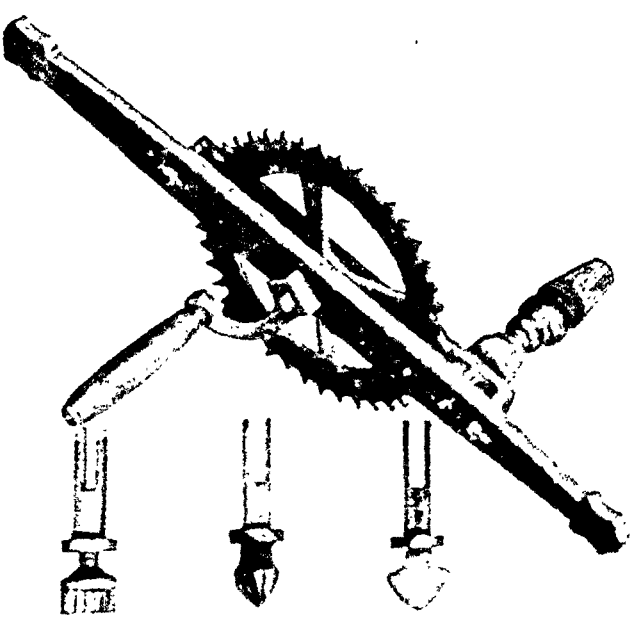


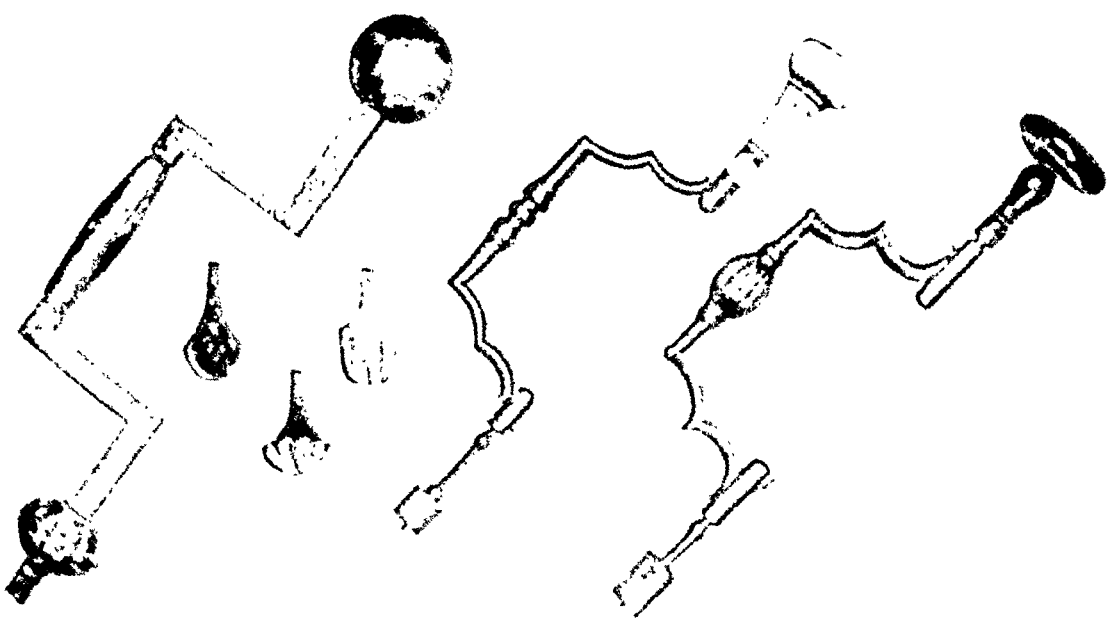
Fig. 26.—The mechanical trepan introduced by Matthia Narvatio in 1575.

[15] Fabricius ab Aquapendente, *Opera Chirurgica*, 1628, Frankfurt. In the Leyden edition, 1723, is a figure of the trypana of Fabricius with a cross handle.

menting on the instrument, says, "the name trephine is so-called from the triangular form it acquires by the horizontal position of the handle, in contradistinction to the trepan in which the head or crown is affixed to a frame or brace similar to and used in the manner of the carpenter's wimble." *Fig.* 27. To Fabricius is also attributed the invention of the circular saw with shoulders, with the object of preventing the instrument from sinking down into the membranes of the brain.

Ambroise Paré, who often operated on the battlefield, employed the brace or drill-stock with a binding screw to fix the saw, the drum of which was straight and smooth, but with a shoulder similar to that recommended by Fabricius. He describes in his work on surgery "trepanes or round saws for cutting out a circular piece of bone with a sharp-pointed nail in the centre projecting beyond the teeth." He also figures a trephine with a transverse handle of metal similar to the instrument introduced by Sharp two centuries later. *Fig.* 28 (2).

In 1639 John Woodall, a surgeon of St. Bartholomew's and author of *The Surgeon's Mate,* described his "trafine as an implement of my owne



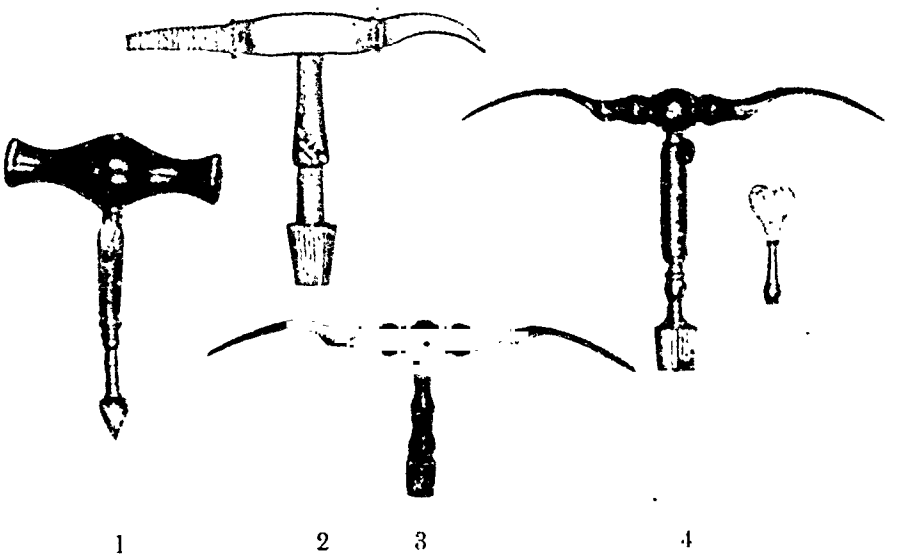


FIG. 28.—1, The *trepan perforatif* and *trepan piramide* of Garengeot (1725); 2, Type of trephine used in 1579; 3, Perforator introduced by Petit in 1779; 4, Sharp's trephine and key for removing centre-pin (1729).

composing," being probably unaware that Fabricius had preceded him.

Scultetus in his *Chyrurgeon's Store House,* describes what he terms as a "male" and "female" trepan, the former having a centre-pin and the latter without. "Before we use the females," he writes, "we must make some print upon the skull with the male so that the females may stand the faster upon it. Now for to trepan the skull the Chyrurgian must have at hand at least three trepans exactly equal one to the other; one male and two females, so that he may oft-times change them." He describes "the scraping tool called a lenticular and the levitor or elevator to bring the cut bone forth." He also figures a trephine, "an iron instrument having three sorts of trepans," and an instrument called the *triploides* for raising depressions of the skull in place of the levitor. *Fig.* 30.

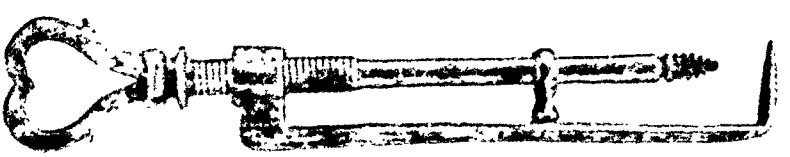


FIG. 29.—An early eighteenth-century instrument for raising depressed bone. (*From the Historical Collection, Royal College of Surgeons.*)

During the eighteenth century several alterations were suggested in the trephine, and in 1725 Garengeot first described his *trepan perforatif* and *trepan piramide*. *Fig.* 28 (1).

Fourteen years later, Samuel Sharp of Guy's, a pupil of Cheselden, introduced his trephine, which had a wide transverse handle of steel, the extremities of which were roughened for use as elevators. He claimed to be the first to use a trephine with a cylindrical instead of a conical crown-saw, the centre-pin of which could be removed by means of a key. *Fig.* 28 (4).

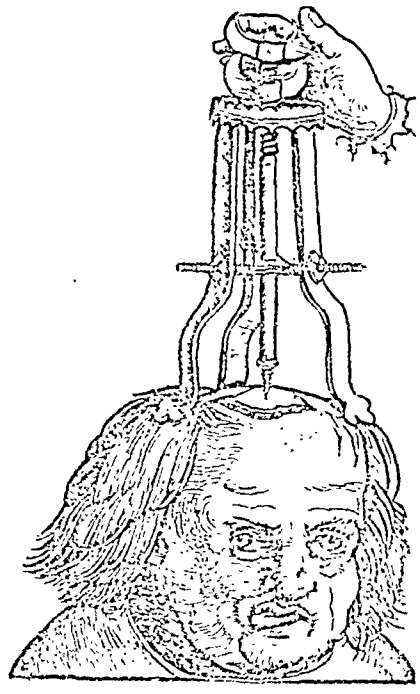
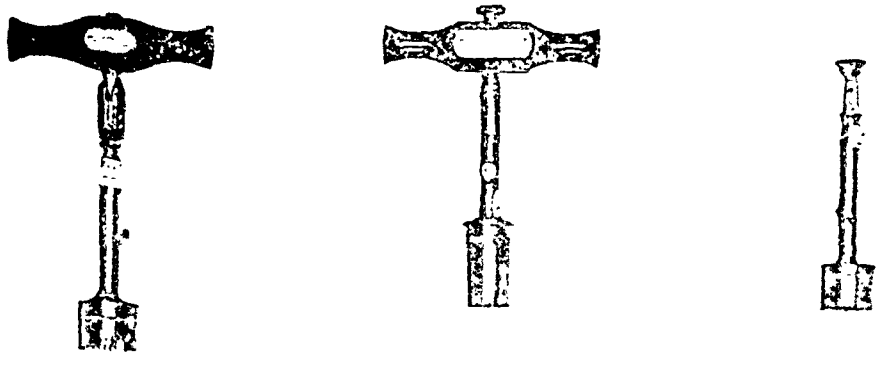


FIG. 30.—The triploides (1632).

In 1743, Heister described his conical crown-saw, and stated "the moderns have a method of fastening the crown on the trepan otherwise than by screwing, but this is my way." He also introduced an exfoliative trepan, the handle and saw of which was fashioned from one piece of steel.

In 1779, Petit described his perforator, which had a steel drill-head, smooth and bevelled, for drill edges, which he claimed to be an improvement on Sharp's on account of its being shorter; and in 1782, Brambilla



1 2 3

FIG. 31.—1, Trephine introduced by Benjamin Bell in 1801: 2, Savigny's trephine (1798); 3, Rudtorffer's trephine, with smooth drum and screw button in shaft.

figured a trephine very similar in shape to the one introduced by Sharp.

At the close of the eighteenth century, Savigny, writing in 1798, says, "at this time, the trepan used with a brace or wimble is now wholly laid aside in this country." He describes the type of trephine, *Fig.* 31 (2), then in use as "a cylindrical saw with a smooth drum, the barrel of which is inserted into the handle direct. The pin has fine teeth with no gaps, and runs in a slot in the barrel, being regulated by a binding-screw and plate. The teeth are perpendicular, which formation is claimed to be an important advantage to the operator."

Then came Benjamin Bell, who introduced his improved trephine in 1801. It had a wooden cross-bar, into the middle of which was screwed a steel key-barrel with a spring grip made to grasp a slot cut in the key end of the trephine saw. The saw itself had a cylindrical smooth drum with long straight teeth, but, unlike others, these were arranged in three series of nine, and thus three gaps were left to let out the bone dust. This was the forerunner of the "windows" in the modern instruments. The prismatic was controlled by a thumb or binding screw and plate, which worked in a slot on the side of the brass barrel. *Fig.* 31 (1).

Rudtorffer, of Vienna, in 1817 suggested yet another alteration in the form of a screw button in the shaft to raise or lower the pin, and his trephine had a smooth drum. *Fig.* 31 (3).

Since the middle of the last century little alteration has taken place in the construction of the trephine.

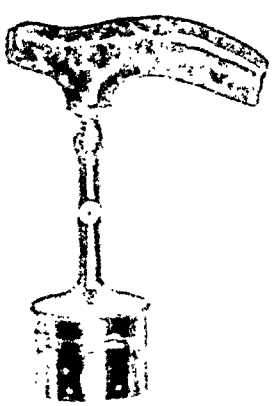


Fig. 32. — Walsham's trephine with crutch handle (1809). This type was used by Sir Victor Horsley

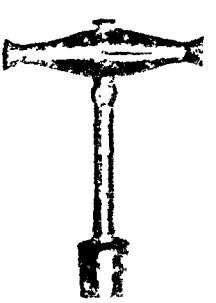


Fig. 33. — A trephine [illegible]

In 1852, Henry Lee introduced a trephine for necrosis nodes, and successfully removed an abscess of the tibia with it. It was later used by Sir James Paget, Brodie, and Fergusson.

Towards the close of the century there was a return to some of the earlier types of instruments. In 1889, Evans introduced a mechanical rotatory trephine, and also mechanical drill-stocks to be used with drills or trephines, and a pattern with an Archimedian screw-action appeared in the instrument-makers' catalogues. Macewen's brace was but an adaptation of the early wimble, and Roger's "skull plough" a reversion to primitive times.

A little later, Walsham introduced a trephine with a crutch-shaped handle, a type which was later favoured by Sir Victor Horsley, but since that time no marked change appears to have been made in the instrument employed on the cranium. *Figs.* 32, 33.

· V ·

THE VAGINAL DILATOR AND SPECULUM

THE history of the vaginal dilator and speculum, which dates from the early centuries of the Christian era, is one of special interest to obstetricians and gynaecologists. It is more than probable that the idea of the expanding-bladed instrument, which we know from existing specimens was used by the Romans, was evolved from the hand of the obstetrician with the fingers first placed together in the shape of a cone for introduction and then spread outwards for exploration.

This supposition is borne out to some extent by the directions given in Celsus[11] for examination of the cervix uteri: "The operator," he says, "having greased his hand, ought first to insert the index finger and keep it there until the os uteri be further opened, and then he should again introduce another finger, inserting the remainder in the same way until the whole hand be in the womb."

As the instrument later developed in two distinct forms, viz., the bladed and the tubular, it will be well to consider them separately.

Although Hippocrates makes no special mention of the vaginal dilator, he alludes to two different kinds of rectal dilators similar in construction to the bladed instrument later used for the vagina, and the references to lesions of the cervix uteri lead one to think that some kind of instrument was employed. In the passage on the diseases of women in the Hippocratic treatise, dilators consisting of six flat pieces of pine, each a little longer than the other, are alluded to. These, after being well smeared with oil, were to be introduced to dilate the vagina. *Fig.* 34 (1).

The earliest dilators so far known are those of bronze found among the surgical instruments discovered at Pompeii, which was destroyed A.D. 79. One of these has four blades and the other three, and they are worked by different mechanisms. The four-bladed specimen works on a frame, the two upper blades being hinged to the top of the handles and

[11] Celsus, Book VII. Cap. 5, Sec. 4.

held by a cross-bar tipped with rams' heads. On turning the central screw, the lower blades are drawn outwards, at the same time separating slightly, while the upper blades also diverge. The total length of the instrument is 13 inches. *Fig.* 34 (2).

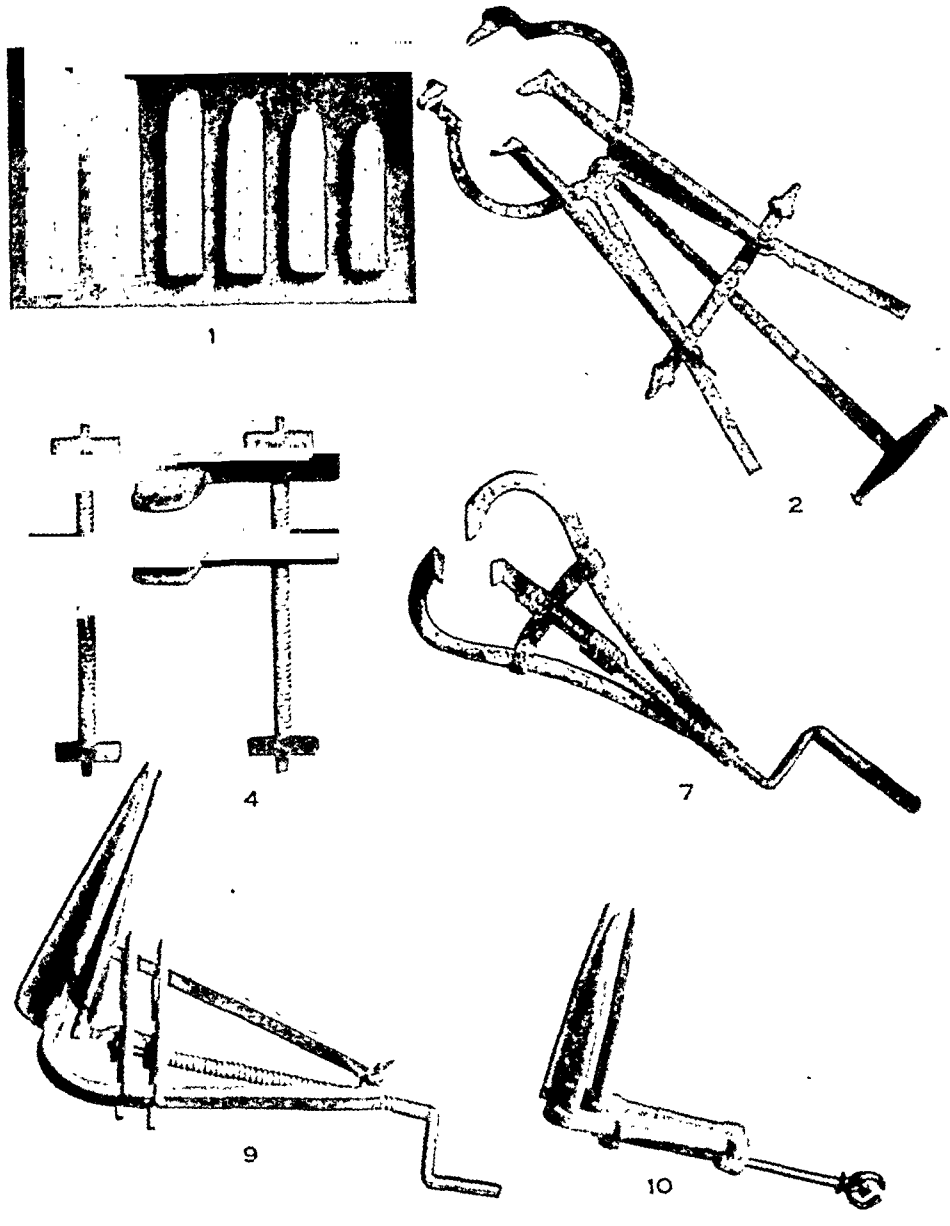


FIG. 34.—1, Flat pieces of pine wood of increasing length, used in the time of Hippocrates to dilate the vagina. 2, Four-bladed bronze dilator discovered at Pompeii (before A.D. 79). 4, Ebony or boxwood dilator described in the earlier of the Albucasis manuscripts in the Bodleian Library (1271). 7, A dilator of the sixteenth century. 9, A dilator in the Prujean Collection. 10, Three-bladed speculum depicted by Scultetus (1672).

The three-bladed dilator, with its central screw mechanism, became the model for later instruments down through the Middle Ages. The blades are prismatic and the points blunted. The two lateral stand at right angles to a flat-sided bar. At their extremities they turn inward and are united to each other by a round hinged-joint. A rod passes through the hinge and is received by a linch-pin on the upper surface. A special feature of the instrument is two flat bars, convex externally and prolonged below the side-bars, each attached to the corresponding side-bar by a hinged-joint. Thus they can be pushed outwards, out of the way, when the screw is being turned, and then pressed inwards so as to meet close above the handle of the screw. This arrangement allows the dilator to be firmly grasped. *Fig.* 35.

The anatomist and obstetrician, Soranus, who flourished from A.D. 98 to 177, devotes a chapter in his book on gynaecology to the use of the vaginal speculum, beginning with an account of the position to be assumed and describing how, after greasing the blades, the instrument is to be introduced. We learn from Paul of Aegina that Leonidas of Alexandria (A.D. 200) stated that the anus must be dilated like the vagina of women by means of the anal dilator, and as far as is known, no further allusion to the instrument is made until the time of Albucasis, who in his work on surgery describes several types, some of which are depicted in the manuscripts of his work (936-1013). In the manuscripts in the Bodleian Library, dating respectively about 1271 and 1465, three kinds are represented. A model of one taken from the earlier manuscript has

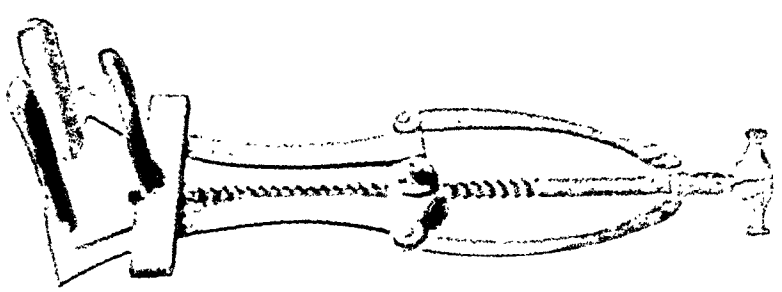


FIG. 35.—Three-bladed bronze dilator discovered at Pompeii (c. A.D. 79).

Fig. 36.—Other types of dilator described by Albucasis (MS. c. 1271).

screws at the ends of two flat pieces of boxwood or ebony. "The width of each piece of wood is to be 2 inches, the breadth 1 inch, and the length about a span and a half. In the middle of each, firmly fixed on, are two other pieces of wood each half a span long, and it is these two extra pieces which are to be introduced into the passage and thereby opened when the screws are turned. *Fig.* 34 (4).

Another kind, also made of ebony or boxwood, was shaped like a

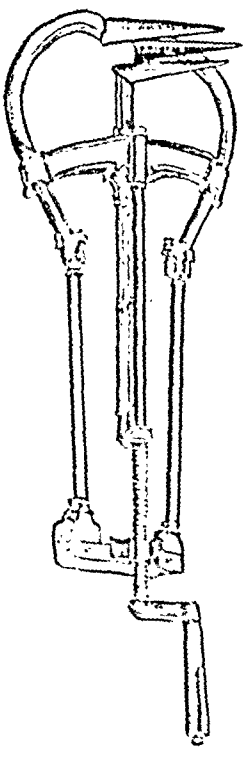


Fig. 37.—The *speculum matricis* of Gersdorff (1526)

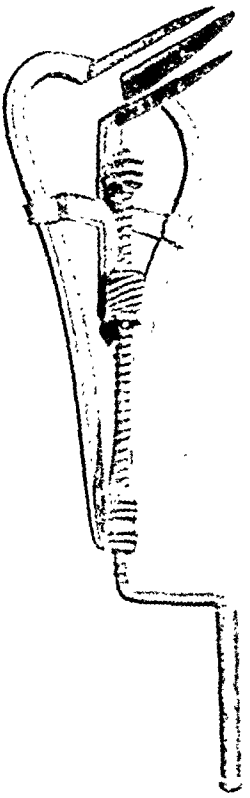


Fig. 38.—A speculum of the sixteenth century.

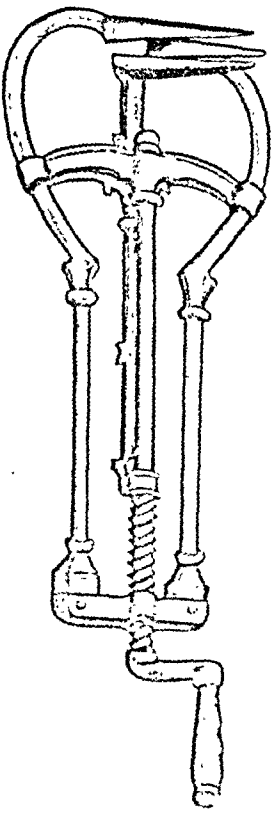


Fig. 39.—The *speculum matricis* described by Roesslin (1513)

forceps, the two bent ends being inserted into the womb and the long bow-shaped handles providing the spring. *Fig.* 36 (1). A third type represented is a screw speculum which Albucasis states is "a kind mentioned by the ancients." In this instrument the jaws apparently opened and closed by a single spring. *Fig.* 36 (2).

Guy de Chauliac, in his *Chirurgia Magna,* 1363, writing on the extraction of the child, directs the surgeon "to introduce the instrument called Speculum which is provided with a thumb-screw and dilate the vagina as much as possible." No description is given of this instrument, but in 1526 Gersdorff, who served as a surgeon during the wars of Charles the Bold in 1476-77, published in his *Feldtbuch der Wundartzney* a *speculum matricis* which he describes as "Speculum, that is—to open the anus or the birthparts of women." *Fig.* 37. In the text he refers to it as "a surgical instrument also used in obstetrics."

About the middle of the sixteenth century the *speculum matricis* appears to have excited much interest, and was recommended for use by midwives. *Fig.* 38.

In 1554 Rueff, a surgeon who is said to have superintended the mid-

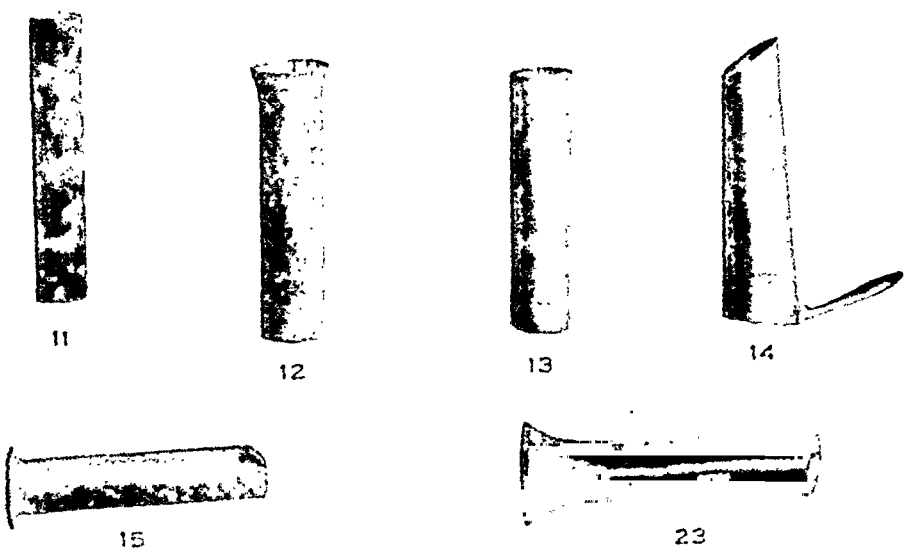


Fig. 39. Tubular speculums (for description, see text).

wives of Zurich, wrote a book entitled *De Conceptu,* in which he figures his *speculum matricis,* which he says is to be used when "children sticking in the womb and being dead are to be brought forth." He gives a long account of how the midwife should use such instruments, one of which he refers to as the *apertorium,* a long cross-bladed dilator or the opening instrument, and the other as the *speculum matricis, Fig.* 39, the "looking-glass of the matrix." There is some evidence that a mirror was used in connection with this instrument.

There can be no doubt that the *speculum matricis* was not meant to be a dilator of the cervix but an expander of the vagina, a speculum in fact as that word is now understood. It is interesting to note that both in Gersdorff's and Rueff's instruments the blades are concave internally and not prismatic.

Later on in the century the vaginal dilator began to undergo a definite development, which is shown in the instruments figured in the works of Ambroise Paré in 1579. In one, termed the *Vielle* type, the screw apparatus and bars are encased up to the blades between plates on their upper and lower surfaces, the screw being worked by a winch. Another is almost identical with Rueff's, the male-screw passing through the horizontal bar and not through a bearing on that bar. This is also worked by a winch. In the third type, the bearing on the horizontal bar for the male screw is a large metal nut and the screw is worked by a thumb-piece instead of a winch.

In the Prujean Collection of instruments preserved in the Royal College of Physicians is a formidable instrument with three long, sharp-pointed blades each measuring 6½ inches long, which are worked by a central screw. *Fig.* 34 (9).

Early in the seventeenth century Fabricius ab Aquapendente figured a three-bladed dilator with a screw apparatus between the handles for expanding the blades, and in 1606 Fabricius Hildanus depicted a similar instrument.

Another type of the three-bladed speculum is shown by Scultetus in his *Armamentarium Chirurgici* (1672). He states that the instrument

"should be used when the dead child is to be cut out or some ulcer of the matrix is to be viewed." *Fig.* 34 (10).

Coming to the eighteenth century, we find that marked changes took place in the form of the dilator and speculum and that various modifications of the tubular type came into favour.

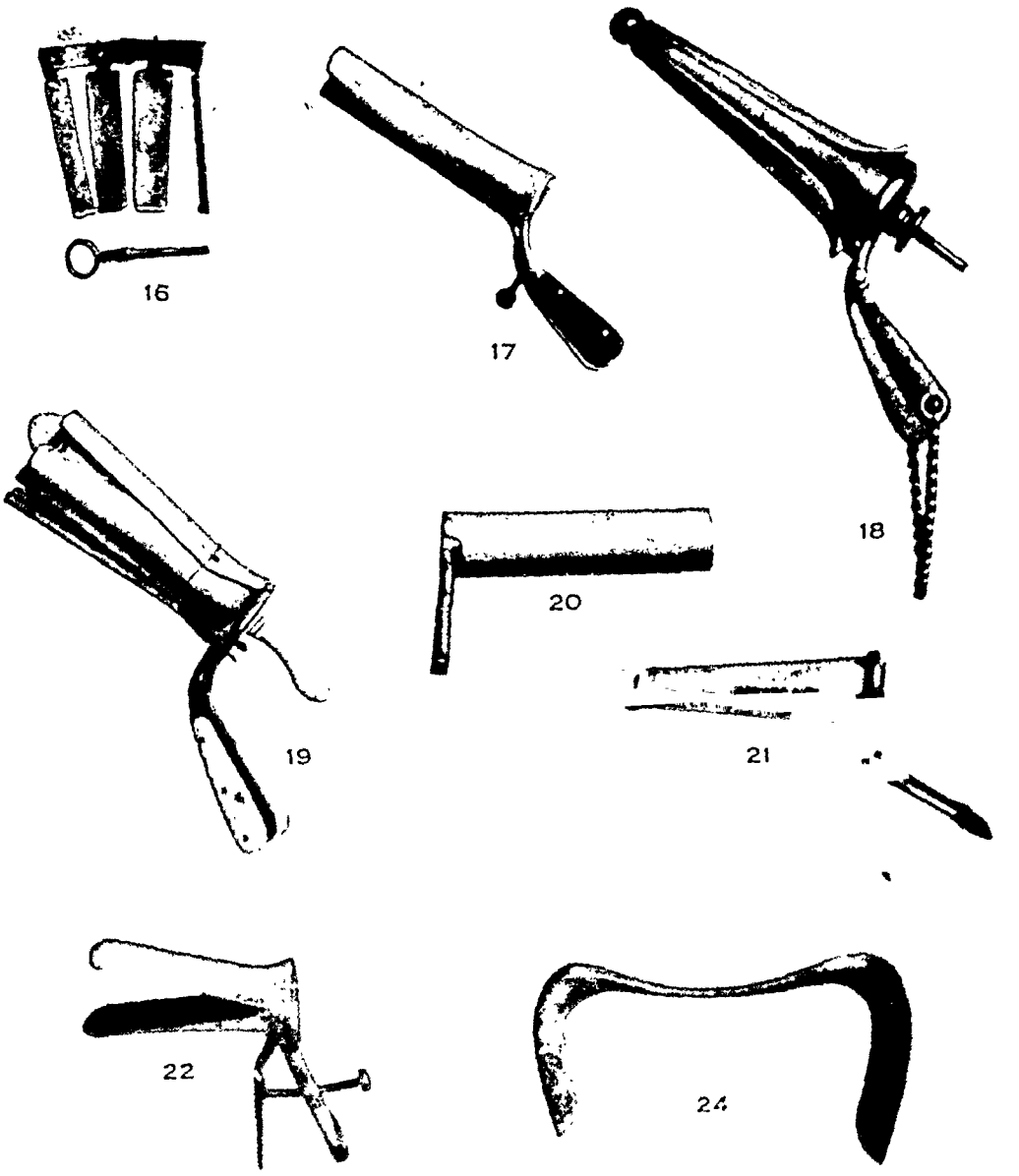


Fig. 33.—Various types of speculæ. 16, Beaumont's (1837); 17, Ricord's; 18, David Davis' (1839); 19, Charrière's; 20, Recamier and Segalas's (1842); 21, Bozeli's, 22, Cusco's, 24, Marion Sim's.

The tubular speculum, a gynaecological rather than an obstetrical instrument, was probably of equal antiquity with the bladed type, as the Talmud explains how a woman may ascertain if blood issues from the womb by introducing a tube into the vagina and passing a rod with a cotton tampon along the tube. The tube may have been a bamboo internode or the stem of a gourd. *Fig.* 40 (11). Metal tubes were used from an early period, and are mentioned by Mar Samuel about A.D. 160. Although the cylindrical shape, *Fig.* 40 (12, 13), was slightly altered by division into valves from time to time, the tubular remained until the nineteenth century. Later types of tubular specula are shown in *Fig.* 40 (14, 15).

In 1830, David Davis introduced a four-bladed instrument with a plug which was devised to prevent the mucous membrane from falling between the blades. The plugs were first made of wood, for which vulcanite was later substituted. *Fig.* 41 (18). A few years afterwards Magenty and Columbat devised a speculum with five or six short blades on a metal collar, and in 1837 Beaumont, an ingenious English surgeon who afterwards went to Canada, introduced his new speculum which reverted to an ancient type. Before he left London for Canada, he published an account of his "New Speculum Vaginae" in the *London Medical Gazette* (1837), in which he states that he had constructed it "to aid in operating on vesicovaginal and rectovaginal fistulae." It consisted of four or five steel blades each 3 inches long, like the wooden wedges of Hippocratic times. These blades were fixed around two-thirds of a metal hemisphere, about an inch in diameter, with a screw in its centre worked by a handle passing into the blades. Each of the blades also had a screw which drew them together by means of a string, which on the instrument being introduced allowed the blades to expand and the handle to be unscrewed. *Fig.* 41 (16). Each blade could be opened separately, and between them nearly one-third of the vagina was exposed.

During the next fifty years many new types were introduced and the bivalve or "duck's bill" came into vogue. Among these was Ricord's speculum, *Fig.* 41 (17), which formed a connecting link between the

bladed and tubular. In 1842 Recamier and Segalas advocated a split tubular instrument with four valves, only one of which functioned, *Fig.* 41 (20); and in 1753 Heister described a bivalve speculum "to dilate the anus or vagina." Rizzoli, Charriere, Cusco, and Trélat also introduced instruments designed on similar lines, *Fig.* 41 (19, 21, 22), and later, Brambilla, in 1782, figured a two-valved speculum, the long blades of which were operated by a transverse bar with a screw in the centre, and expanded when pressure was put on the handles.

In the early nineteenth century two new instruments were introduced which may be regarded as novelties. The first was a vaginal speculum with glass blades; and later came Palfrey's (Blackbee's) skeleton-bladed instrument, so devised to give an extensive view of the vagina and cervix uteri.

Later on Plum and Weiss revived the use of the three-bladed dilator with three prong-like blades and a plug. It was operated by a screw in the handle, and was recommended for both uterine and rectal purposes. *Fig.* 42 (25-27).

About 1855, Robert Ferguson (1799-1865), the first Professor of Obstetric Medicine to King's College, began to use a straight tubular glass speculum. In 1870, Sir William Fergusson refers to this instrument as "the speculum that I devised" and it is the type which survives to-day. These instruments were originally made of metal and then of glass mir-

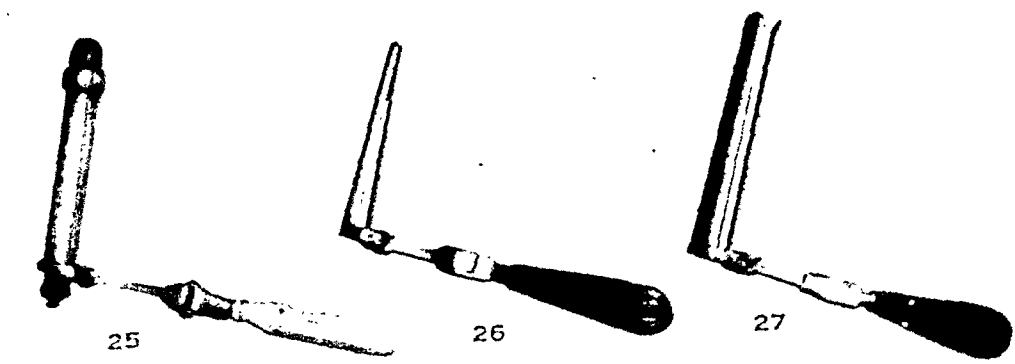


Fig. 42.—Nineteenth-century models of the three-bladed dilator. 25, Plum's; 26 and 27, Weiss's.

rored inside, the outside being coated with several layers of gum-elastic. Walsh added a linen web, woven over the first coating of gum in order to prevent breakage. *Fig.* 40 (23).

And so the origin of the tubular speculum with silvered glass inside is somewhat uncertain, but evidence points to Robert Ferguson as the inventor.

In 1845, Marion Sims introduced his double-ended duck-bill speculum, the shape of which he states in *The Story of My Life,* he discovered by chance. He says that when journeying to visit a patient at a distance one day, finding he had forgotten his speculum, he stopped at a hardware store and bought a long pewter gravy spoon. By bending each end backwards at right angles, he improvised an instrument that he found answered the purpose excellently.

Later on, he used a single-bladed instrument made more concave than the spoon bowl, but eventually added a second blade at the end, as he found when one blade was introduced into the vagina the other made an excellent handle. *Fig.* 41 (24).

From this brief outline of the history of the vaginal dilator it will be seen how the tubular outlived the tri-valved *speculum matricis* of the early centuries, and survived the many types of tri-valved and quadri-valved gynaecological instruments of the eighteenth and nineteenth centuries.

· VI ·

HEAD-SAWS

THE use of the head- or hand-saw for opening up the skull goes back at least four thousand years, and its employment in the near East about that period is proved by a skull excavated by the late Mr. Starky at Lalash a short time ago. This discovery is of special interest as it shows that the operation was carried out in the same manner as that employed by the ancient people of Peru, the cranium being first sawed in two directions and a square piece of bone then extracted.

As in the case of other early instruments used for surgical purposes, the primitive flint implement then employed was succeeded later on by small saws with blades of copper or iron.

The first representation we have of the head saw is that given in the *Chirurgie* of Albucasis in manuscripts of the twelfth and thirteenth centuries, where it is depicted with a slightly curved blade and also with a blade almost circular in shape. *Fig.* 43 (1).

He describes the instrument as "the little saw sometimes used to cut away the spaces between the holes made in the skull by the trepan."

In the fourteenth century there is evidence, from the drawing in Wryghtson's manuscript at St. John's College, Oxford, that a crescent-shaped blade with the serrated edge on the outside was used in that period, *Fig.* 43 (2), and this type probably continued in use until the sixteenth century, when we find eight different varieties of the instrument in the works of Andreas della Croce. One of these has a small oblong blade with a slightly curved sawing edge fixed to a handle, by means of which it was operated. Another has the blade curved backwards with the serrated edge on the outside, while a third is shaped like a halberd, with double saws fixed on either side of the shaft. *Figs.* 43 (4), 44.

The development from the curved into the semicircular edge seems to be traceable from the time of Wryghtson to Della Croce, who shows a type with a highly convex sawing edge. *Fig.* 45. Ambroise Paré in his

Chirurgie (1560) depicts several types of head-saws, which he describes as "saws fit to divide the skull," *Fig.* 46, while Fabricius ab Aquapendente figures a head-saw, the blade of which is curved slightly backwards, with the cutting edge on the outside. *Fig.* 47. Fabricius Hildanus about the same period (1560-1624) gives a representation of an instrument with a head of peculiar shape. *Fig.* 48. The serrated edge is on the outside of a semicircular blade, while on the other side the curve has indentations of various shapes, probably intended for breaking away pieces of bone, and below these a small straight saw.

In 1674 Scultetus figured a small hand-saw, which closely resembles some of the later types, with which, he says, "some men cut away the distances between the holes made in the skull with the trepans and abolish rifts like hairs that do not penetrate and scrape away the rottenness of the cranium," thus repeating the use of the instrument given by Albucasis. *Fig.* 49.

From this period the head-saw appears to have fallen into disuse for over a century, until in 1783 it was revived by Cockell, a surgeon of Pontefract, who is said to have "used the saw he devised with great advantage

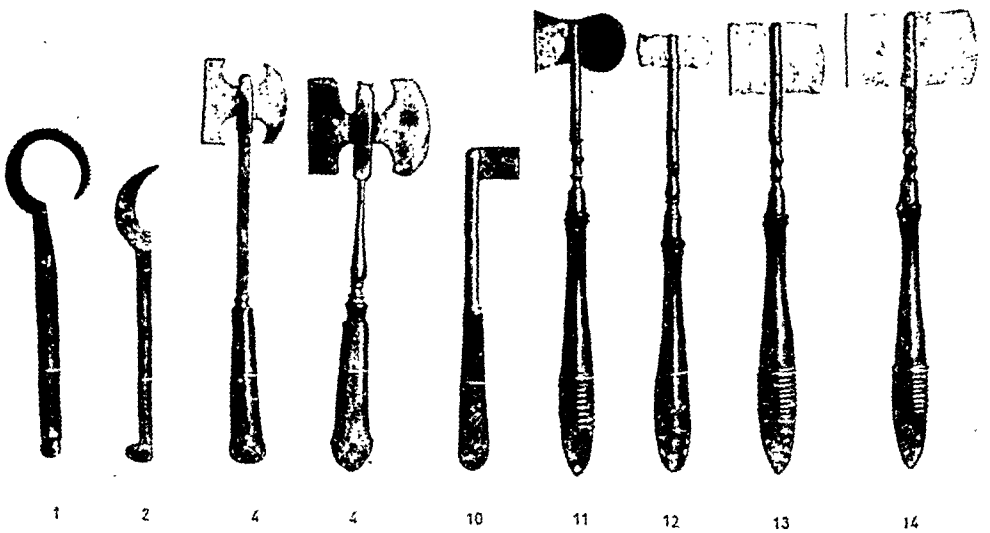
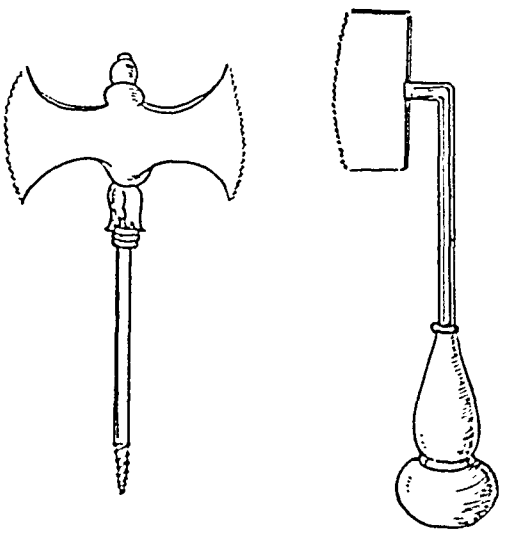


FIG. 43.—Head-saws: 1, Albucasis (twelfth and thirteenth centuries); 2, Wryghtson (fourteenth century); 4, Andreas della Croce (sixteenth century); 10, Cockell's (1783); 11-14, Hey's (1803).

in extensive fractures of the skull." The blades of Cockell's saws varied in shape, some having a semicircular sawing edge and others a smaller straight blade with convex edges. *Fig.* 43 (10).

Twenty years later, in 1803, William Hey, F.R.S., senior surgeon to



FIGS. 44, 45.—Head-saws as used by Andreas della Croce (1573).

FIG. 46. — Head-saw used by Ambroise Paré (1560).

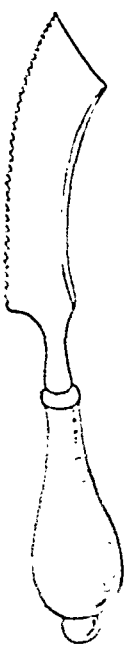


FIG. 47. — Type used by Fabricius Aquapendente.

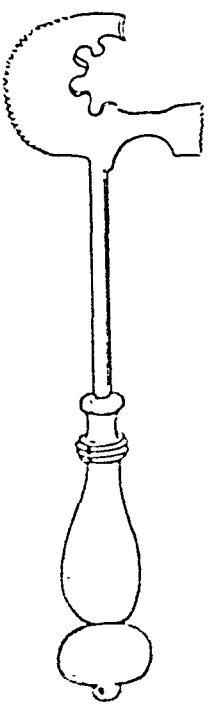


FIG. 48. —Type illustrated by Fabricius Hildanus.

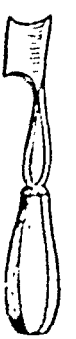


FIG. 49. —The small hand-saw used by Scultetus (1674).

the General Infirmary at Leeds, again advocated the use of the head-saw in cranial operations. It is evident from the difference in the shape of the blades that Hey gave very careful thought to the designing of his saw, as shown in the six examples which he used himself that are now in the collection of instruments in the Museum of the Royal College of Surgeons. In his *Practical Observations on Surgery* (1803), in referring to his saw, he says: "Such a saw I can with confidence recommend after a trial of twenty years, during which time I have rarely used the trephine in fractures of the skull.

"It was first shown me by Mr. (now Dr.) Cockell, an ingenious practitioner of Pontefract, to whom the public is indebted for the discovery or revival of this excellent instrument.

"Dr. Cockell's saw has a semi-lunar edge, but the edge may be straight or of any degree of convexity which may be thought most useful. The straight-edged saw executes its task with greater readiness, but the convex edge is necessary when the bone is to be sawed in a curvilinear direction. It is also useful when the thickness of that part of the cranium which is to be sawed through is very unequal."

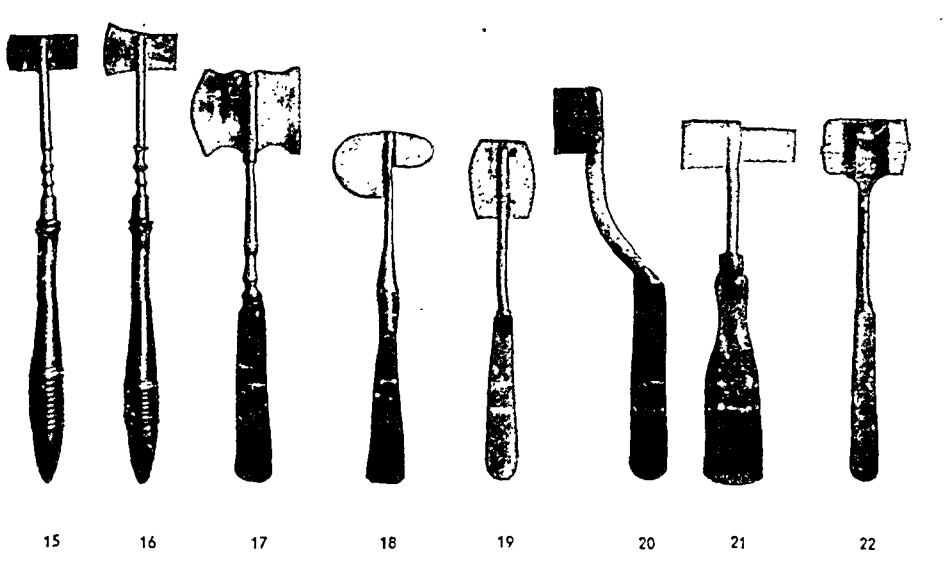


FIG. 50.—Hey's saws: 15, 16, Later patterns; 17, An early pattern; 18, With asymmetrical semi-circular sawing edges; 19, With symmetrical convex sawing edges; 20, With single straight blade and curved stem; 21, With asymmetrical straight sawing edges; 22, With spring guard.

As Cockell and Hey advocated varying degrees of convexity, it is not surprising that such variations are displayed in Hey's own set which he used in the Leeds Infirmary. *Figs.* 43 (11-14), 50 (15, 16).

Hey's original pattern had a metal stem on a wooden handle: the stem was split at its free end and the single straight blade was fitted at right angles into the slot thus formed by two screws. Of the other types he devised one had an asymmetrical semicircular cutting edge, *Fig.* 50 (18), another a single straight blade with a curved stem, while to another a projecting spring guard was added, the two pieces of steel being probably designed for cleaning the groove made by the saw. *Fig.* 50 (22). In 1878 Bigger described a head-saw of Hey's type which had teeth also on the concave side, so that both the convex and concave sides of the cutting blade could be employed.

In connection with the head-saws, mention must be made of the circular types introduced in the early nineteenth century.

Among the earlier instruments employed in trepanation the "cutting compasses" figured and described by Ambroise Paré in 1564 are noteworthy, as the principle was revived in much later instruments. Con-

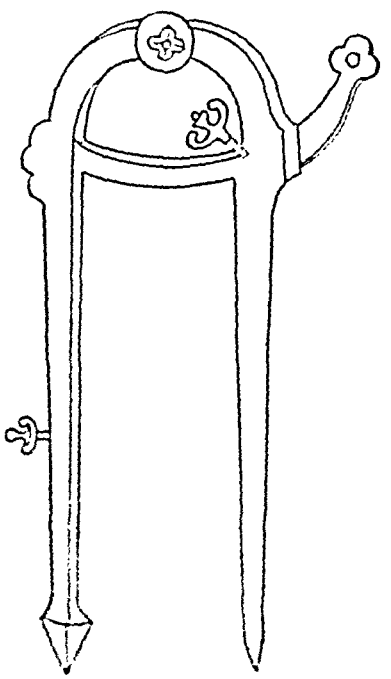


Fig. 51.—Ambroise Paré's cutting compasses (1564).

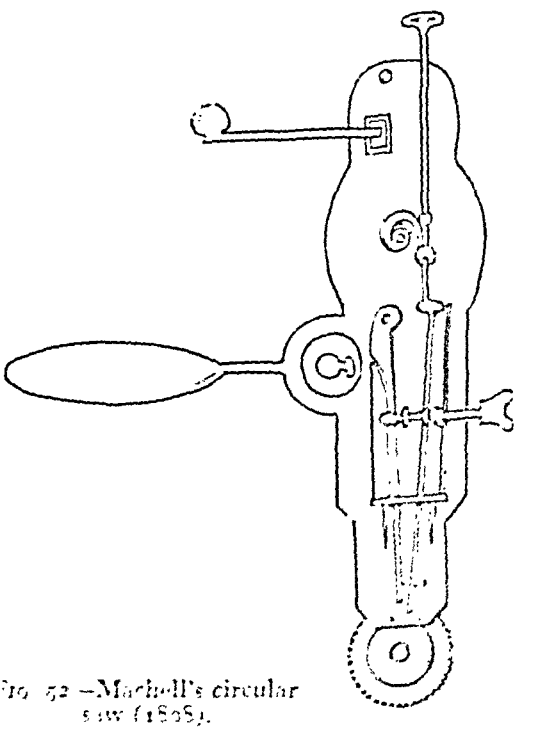


Fig. 52.—Marshall's circular saw (1808).

cerning it Paré says, "For what cause soever we cannot make use of a trepan we may employ the "cutting compasses" to cut forth the skull. If so be much of the bone is bared as is needful, it is made in form of a pair of compasses and by means of a screw may be opened more or less as you please." With it a perforated metal plate was used to protect the cranium into which the pointed shaft of the instrument was to be placed. *Fig.* 51.

A circular saw for cranial surgery was invented by Machell in 1808, and of this he devised several types, *Fig.* 52. In introducing it he says, "the annular saw is acknowledged to supersede the use of the trephine, trepan, Hey's saws, bone-nippers, rasp, and the mallet and chisel in all cases where any portions of carious bones demand the interference of our art to remove it." He claimed it to be specially useful for clearing the ends of the ununited fractured bones. Later, he made various modifications in his original design, and the instrument is figured in *Surgical Essays* by Astley Cooper and Benjamin Travers as "Machell's saw."

Machell's invention was followed by the circular saw devised by Charles Griffiths, an Army surgeon, in 1815, and in conjunction with it a saw and bone-nipper which he suggested for use in cranial surgery.

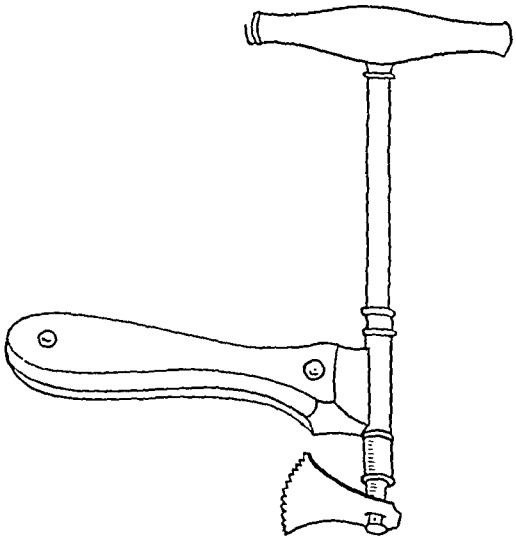


FIG. 53.—Thal's mechanical saw (1823).

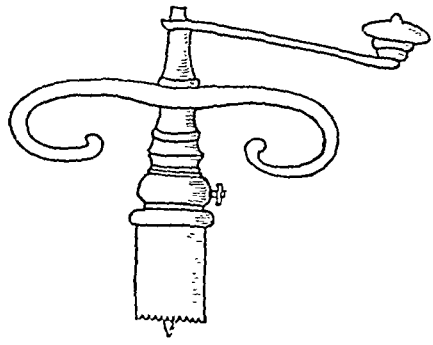


FIG. 54.—Brun's mechanical trepan.

Another mechanical saw was introduced by Thal in 1823. *Fig.* 53. In this instrument the blades consisted of circles or sections of circles of various sizes, which could be fitted to a shaft which was rotated with one hand while the other supported the whole instrument by a handle in which was mounted the main bearing through which the shaft passed.

About 1830, Brun devised his mechanical trepan which was operated with a transverse rotary handle like a mill. *Fig.* 54. This, however, like other contrivances failed to find favour with the surgeons of the time, and it gradually fell out of use.

· VII ·

ARTERY AND DRESSING FORCEPS

THE forceps is an instrument of such infinite variety that its evolution can only be studied from the uses to which from time to time it has been applied.

The term in connection with surgery was originally applied to any instrument for gripping or holding and so naturally covers a wide field.

It is at once obvious that the idea originated from the method of gripping with the forefinger and thumb any foreign or other body it was

FIG. 55. Surgeon extracting an arrow with forceps from the leg of a wounded Roman soldier. From a mosaic found at Pompeii. *c.* A.D. 150-200.

necessary to remove from flesh, and from this instinctive movement the simple metal instrument giving a firmer grip arose.

The first forceps of iron or bronze consisted of a flat strip of metal bent in the centre so the two ends might meet, to hold on pressure the object it was desired to remove.

Many specimens of this ancient and simple device have been discovered in Egypt dating back at least 5000 years and were evidently first used for epilation. We know from the descriptions given in the *Iliad* that the Greek surgeons employed forceps for removing arrow, dart and lance heads from the bodies of their wounded soldiers, and the Romans, whose surgical instruments of bronze show remarkable craftsmanship, soon recognised the value of the forceps for many purposes. *Fig.* 55. Their forceps, in particular, they fashioned with great skill and ingenuity and the workmanship in the cutting and alignment of the jaws with fine teeth cannot be excelled today.

Vulpes mentions that from an inscription excavated near Athens the Greek surgeons were able to tie an artery to stop haemorrhage from wounds, and words implying such are found in a MS. treatise of Archi-

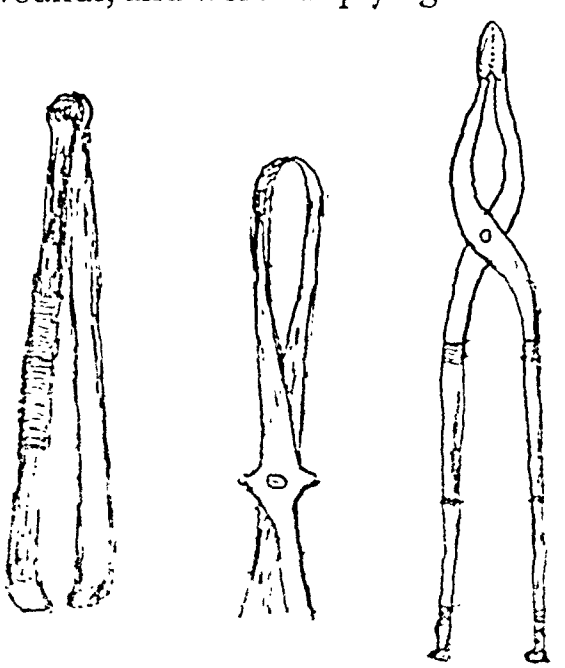


Fig. 56.—Roman bronze forceps (c. A.D. 100–200). From Pompeii.

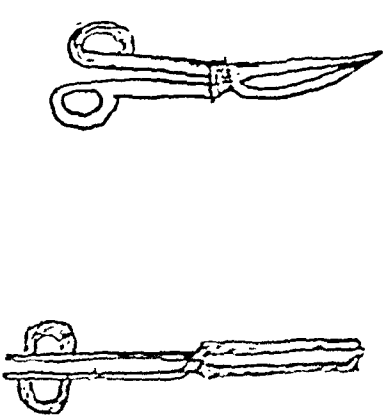


Fig. 57.—Forceps. From a manuscript. Albucasis (12th century).

genes, A.D. 100, in the Laurentian Library at Florence. They read, "the vessels carrying (blood) towards the incision must be tied or sewed up."

The term forceps or vulsella appears to have been first applied to the instrument with long blades in distinction from those with short blades which were usually called pincers.

Celsus mentions the forceps in connection with the extraction of "a stone or some such body which has become embedded." "In all such cases," he says, "the wound must be dilated and the foreign body extracted by the forceps."[17]

From the forceps with straight ends the toothed variety were evolved with the object of getting a firmer grip. These are also mentioned by Celsus as "the vulsella for gripping the uvula and the edges of ulcers," and we know from specimens discovered at Pompeii that the Romans had both toothed and forked forceps in use in the first century. *Fig.* 56. The latter may have been employed for taking up an artery.

Many of their fixation forceps were beautifully fashioned and sometimes ornamented with artistic heads and gilded. The two symmetrical legs closed at the top and were either straight or bent at the extremities so as to put traction on any object such as a tumour in order to excise it. Uvula forceps with finely toothed jaws for first seizing and crushing the uvula were also found at Pompeii. The "myzon" mentioned by Soranus in the second century, was a toothed forceps with a ring slide, like the artery forceps of later times, the legs having spoon-shaped jaws. There

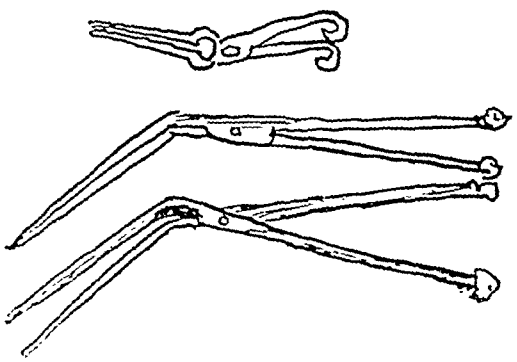


FIG. 58.—Ambroise Paré's *Bec de Corbin* and *bullet forceps*. From a woodcut (1585).

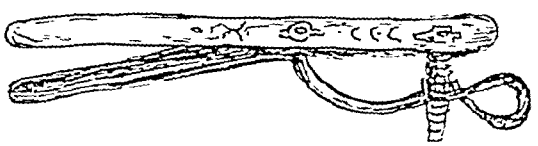


FIG. 59.—The deceitful forceps. Scultetus (1674).

FIG. 60.—A puller and vulsella. Scultetus (1674).

[17] CELSUS, Book VII. Cap. 5, Sec. 4.

were also pointed forceps with jaws sharpened for cutting in order to extract deeply implaced bodies. In this way, objects could be reached that were embedded below the surface. These instruments were sometimes combined with a short knife having a curved or straight blade that could be used for the same purpose.

There was no systematic attempt in works on surgery to figure instruments until the time of Albucasis in the tenth century when we find many representations of those employed by surgeons in that period. In the manuscript on *Chirurgia* by the Arab surgeon in the Bodleian Library (MS. 156) there are drawings of two long bladed forceps with locks, one of which has finger grips. *Fig.* 57. These were obviously employed for extracting foreign bodies from wounds, having a long reach and giving a firm grip. We know of no further developments until the time of Andreas della Croce (1500-1575). In his *Cirurgia,* he describes five different types of forceps for removing fragments of bone or for haemorrhoids, and Ryff, about the same period, figures an aural forceps for extracting foreign bodies from the ear. Ambroise Paré describes the *Bec de Corbin ou de Perroquet* which was similar to the modern hemostats for pinching the vein or artery to arrest haemorrhage, and also figures a bullet-forceps with curved blades and roughened extremities. He also shows an artery, hooked-forceps, which he employed for removing fragments of bone and splinters of bone from a fractured skull. *Fig.* 58.

About the end of the sixteenth century, Guillemeau who was Paré's son-in-law, described four kinds of forceps for removing foreign bodies

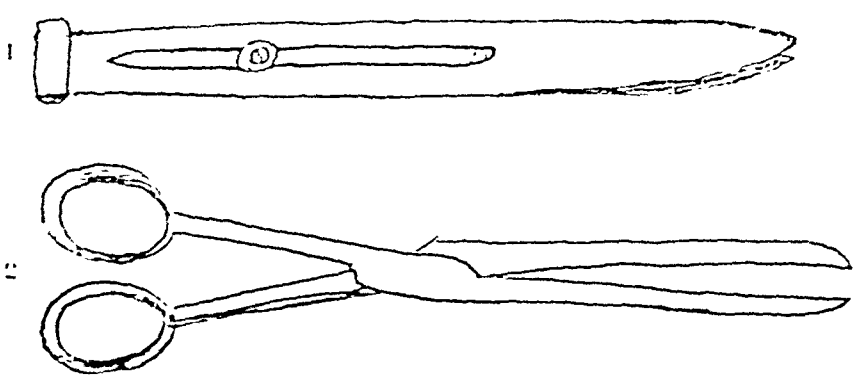


Fig. 61.—Forceps of the 18th century. 1, Sir Benjamin Bell's; 2. Heister's

and later Fabricius Hildanus (1560-1634) figures a forceps with spoon-shaped extremities for the same purpose.

By the time of Scultetus (1595-1645) forceps of several different types had come into use. In his *Armamentarium,* he describes fifteen different varieties including one he calls the "deceitful forceps" which he remarks, "if it deceives not the patient yet it will deceive the chyrurgian as it was the opinion of the ancients in dilating hollow places." *Fig.* 59.

He makes little distinction between forceps and what he terms nippers or pincers and mentions that Celsus and Paulus Aegineta call a vulsella, "a puller with a double and toothed end to it." This was used to remove fragments of bone, darts and "all tents and hairs found in wounds." Other instruments he describes were employed for the same purpose.

The spring vulsella he figures has a spatula at one end which could be used to spread ointment or plaster on linen. *Fig.* 60.

He remarks that this puller "serves singularly well to pull out hairs from the eye-lids which prick the eyes and serves to wait on Physick that is to make women fair; for with this, women especially that belong to Court, pull out by the roots hairs in their eye-brows and from other parts of their bodies." Further, he describes the parrot's-bill with bent blades, the goose-bill and the crane's-bill with straight blades toothed on the insides of the extremities. The names of these instruments were obviously derived from their similarity in shape to the beaks of the various birds.

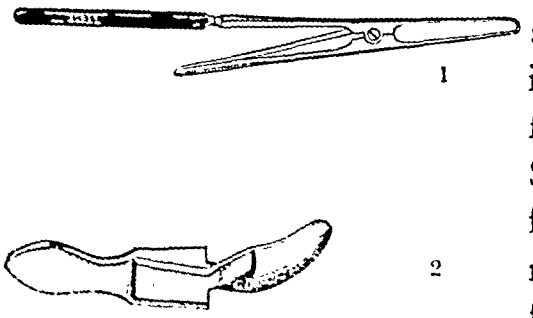


Fig. 62.—Artery forceps. 1, Assalini's; 2, Dieffenbach's.

During the eighteenth century, several new types of forceps were introduced and Petit (1674-1760) figures the artery forceps devised by Schmucker (1712-1786) which had further developments. In 1770, Perret depicts a forceps, probably used for dressings, with curved blades grooved inside, having a box-lock fitted without a pin, the silver handles

with finger grips. Heister in his *Chirurgeria,* however, figures a forceps with a flat blade on which is pivoted a curved blade, both having large teeth, *Fig.* 61 (2), and also a forceps for hare-lip, and Graefe's forceps for uranoplasty.

The forceps introduced by Baron de Wenzel (1728-1800) were of three types viz., the ocular, epilation and splinter, and are figured by Brambilla and Savigny.

In 1787, Desault advocated the use of the first artery compression forceps which differed from any others on account of the spring device which closed the jaws and held their grip; in 1790, Benjamin Bell improved on this in the forceps that were long known by his name or as the English spring forceps. *Fig.* 61 (1).

In 1798, Savigny also depicts a pair of spring forceps with a slide in the handle in order to lay hold of arteries or splinters of bone that may occur during an operation. Assalini (1759-1849) claimed to improve on these by having his made with two adjustable extra arms which brought the legs of the forceps together so the ligature could be pushed over the vessel. *Fig.* 62 (1).

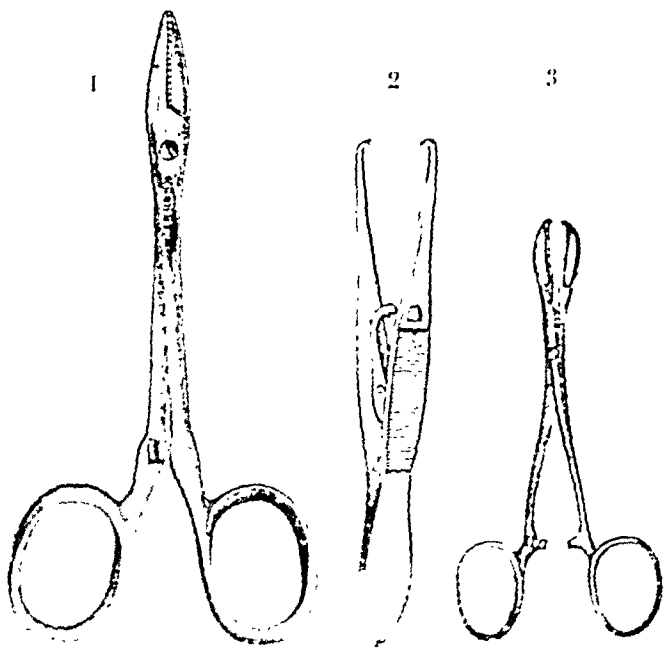


Fig. 62. Artery forceps. 1. Lowe or Tait's; 2. Liston's; 3. Merrett-Baker's.

Until the middle of the nineteenth century the tenaculum was in general use by surgeons, and as late as 1873 Lister testified that the tenaculum had long been universally employed for seizing the bleeding vessels in order to tie them, but it had been superseded by the catch forceps introduced by Robert Liston. *Fig.* 63 (2).

In introducing his tenaculum in 1807, Sir Charles Bell says: "The tenaculum is an instrument in common use for drawing out the artery in open wounds so as to enable the surgeon fairly to tie its mouth. I have given what I conceive to be the necessary curve to it, making the curve a little more acute towards the point." This was followed by Assalini's tenaculum forceps, which was a mouse-toothed instrument with a fixed bar and later by Wardrop's introduced in 1834. Thus, from the tenacula and double-hooks developed the artery forceps some six years later.

It was in 1840, that a new era in the history of the artery forceps was inaugurated by Charriere who introduced an instrument with crossed legs which operated as a clamp. From this evolved two types that since have influenced the shape of the forceps. In one, the legs of the instrument were crossed so as to form a powerful clamp and in the other, the

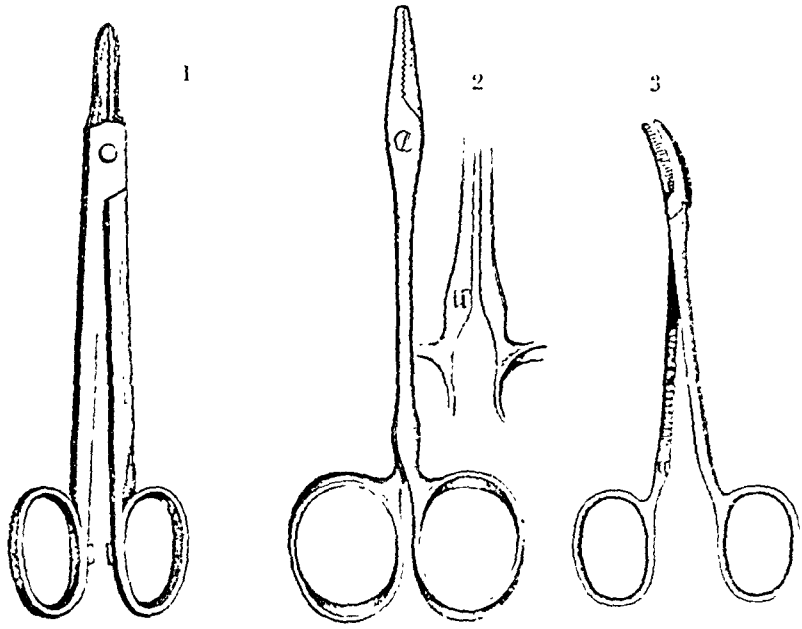


FIG. 64.—Artery forceps invented by Sir Spencer Wells. 1. Original pattern; 2. Improved with lock; 3. With curved blades and aseptic joint.

legs were broader, a modification introduced by Dieffenbach, a surgeon of Berlin. *Fig.* 62 (2). A further advance was made in 1847, when Robert Liston devised a torsion forceps with a spring-catch and from this sprang the "bull-dog" forceps first introduced in 1845, with fenestrated blades, short and deeply curved jaws and teeth.

In 1855, T. H. Wakley, the eldest son of the founder of "The Lancet," introduced his spring-forceps which remained popular for some time with English surgeons and in 1867, Thomas Nunnely of Leeds, made a further advance with his vascular forceps with toothed extremities, which he claimed were sufficiently strong to close the vessels hermetically without causing gangrene or ulceration.

Mention must also be made here of Luke's forceps, without a spring or any mechanical check, the points of the blades being without teeth and almost sharp, and also of the forceps used by Lawson Tait, *Fig.* 63 (1), and Merret-Baker. *Fig.* 63 (3). All these types were later superseded by the pressure or haemostatic forceps introduced by Kolbert, Péau and Spencer-Wells. *Fig.* 64. The last named introduced his well-known pressure forceps about 1887 and they still remain in use. His original pattern had short-toothed blades and long straight handles with oval finger grips, but later he devised one with an improved lock and another type with curved blades and aseptic joint. *Fig.* 64 (3).

· VIII ·

BULLET-FORCEPS AND EXTRACTORS

THE introduction of firearms in warfare about the middle of the thirteenth century opened up a fresh field for surgeons in the treatment of gun-shot wounds, but until the fifteenth century, beyond attempts to extract the bullets near the surface, methods of treatment remained primitive and crude. According to contemporary writers, little was done to assist the healing of the wound or prevent its becoming septic. It was generally believed that gunpowder itself was a burning irritating substance that poisoned the wound and could only be treated by palliatives such as hempseed oil which was poured into the wound. To arrest the flow of blood the red-hot cautery was usually employed. Jerome Braunschwig, the German military surgeon, writing in 1497, recommends warm oil of violets to be poured into the wound in order to neutralise the effects of the gunpowder and the application of camphor and turpentine as local dressings.

John of Vigo, on the other hand, early in the sixteenth century, advocated the use of boiling oil to the wound in order to nullify the poison of the gunpowder, and this barbarous form of treatment continued to be employed, even on the battlefield, until the end of the century.

No special instruments appear to have been devised to remove the soft lead bullets that might be embedded in the body until the first half of the sixteenth century and one of the earliest known was the screw-extractor which is figured in Ketham's *Charethanus Wundartzney* in

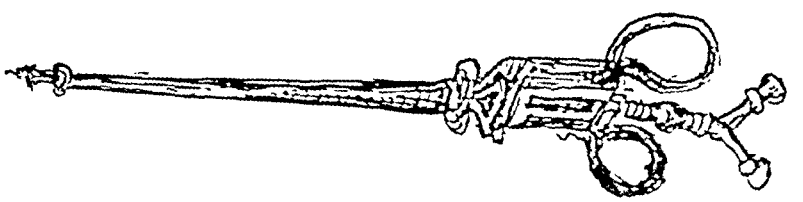


FIG. 65.—A sharp piercer in its pipe or cannula. Scultetus (1674).

1532. This instrument consisted of a straight rod with a sharp gimlet end protected by a cannula which was pushed into the wound and when the bullet was located the gimlet end was screwed into the lead and then withdrawn. A similar instrument is figured by Scultetus. *Fig.* 65.

This instrument went through several modifications some of which are illustrated in the works of Andreas della Croce. Ambroise Paré describes it in 1564 and calls it *Tire-fond,* although he also used a bullet-forceps. The French military surgeons clung to this type of extractor down to the nineteenth century. Besides the screw-extractor, however, forceps of various sorts were employed from the sixteenth century, and in 1563 Andreas della Croce figures an instrument with curved blades serrated on the inside of the points in order to get a grip on the bullet. Paré also used a forceps which he calls the straight Crane's bill and recommended it for extracting small shot or pieces of armour and splinters of bone from deep wounds. He also advocates the use of the Duck's bill, another type, for extracting bullets in deep fleshy parts. *Fig.* 66.

Towards the end of the sixteenth century, Alphonse Ferrius, a surgeon of Naples, introduced an instrument with claws at the end of the blades in order to grip the bullet and remove it from the wound.

It became known as the Alphonsine and for a time was not received

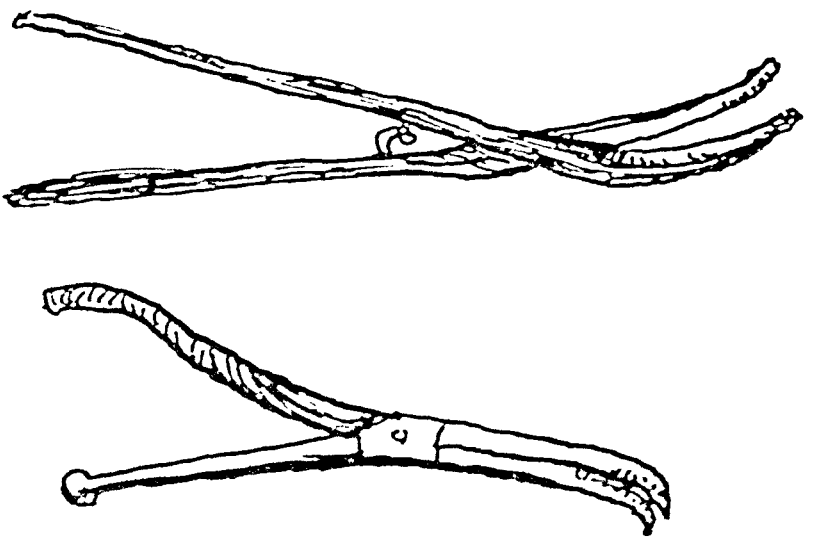


Fig. 66. Bullet-forceps used by Ambroise Paré 1575

with favour, for, says a writer of the time, "it is not yet that instrument which men call the Crane's bill which must not be forgotten, for that it is an excellent instrument to draw forth anything and commended by both old and new chyrurgians. To this we, that it may be more commodious and firmly held in the hand and so bullets and other strange things in wounds may be found out more certainly, have added rings for pincers." The blades of these straight forceps with toothed extremities were encircled by two rings which could be pushed backwards or forwards thus closing the blades and fixing them when the object sought was located. *Fig.* 68.

Maggius figures a bullet-forceps with crossed straight blades terminating with cup-like ends and a screw in the handles to grip the bullet. Another type of screw-extractor with a cannula was also employed which was operated from the handle between the finger grips. *Fig.* 69 (2).

Fabricius Hildanus figures several bullet-extractors of this type which had a vogue in the early seventeenth century.

Concerning instruments for removing bullets Scultetus in his *Armamentarium,* 1674, remarks, "there are divers sorts according to the variety of the wound and the fashion of the body that must be taken out, whereof some lay hold and draw out either as they are sharp and so only stuck into the bullets as others are crooked, to be used as the bullet went in straight or crookedly. If so, the bullet found by the probe must be drawn forth by a pair of pincers taking care that the wounded parts, arteries, veins and nerves be not hurt or laid hold of." He warns operators never to let the pincers be opened unless they feel the bullet at the end of it.

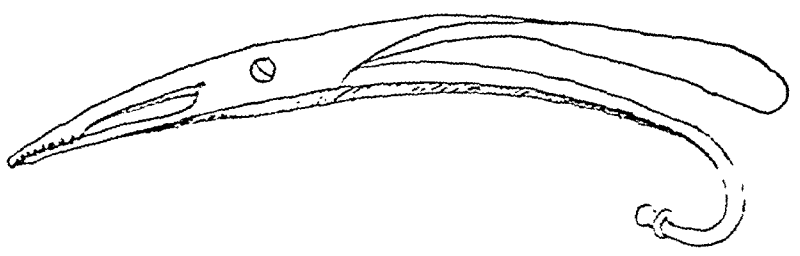


Fig 67.—Bullet forceps. Gersdorf 16th century.

In the eighteenth century several new types of bullet-extractors were introduced and among them was that devised by Savigny but later on Ruspini revived the use of the Alphonsine instrument with three blades. The injurious distending effects of some of the extractors of this type, however, led to the adoption and use of a hinge similar to that employed in midwifery forceps and so, by the division of the forceps into two parts, one blade could be inserted first and used as a probe or explorer to locate the bullet, after which the other could be inserted and the two locked together.

Baron Percy, one of Napoleon's famous army surgeons, devised a similar instrument in 1790 which he called a *tribulcon*. Other modifications of this type were introduced by Eckoldt, and later Luers devised an instrument with two hooks to grip the bullet after it had been located. The hooks were made to fit the cupped free-end of the tube, which had then to be rotated until it became embedded in the bullet which was then to be extracted by the hooks.

Early in the nineteenth century, Savigny introduced a bullet-forceps with a midwifery hinge and later came Coxeter's Extractor. These were followed by Weiss' fitted with a lever which was to be pushed behind the bullet to raise it from its bed. This being done a spring was pushed forward to enable it to be extracted.

Bullet-scoops, another type of extractor, were introduced by Rudtorffer, and in the Peninsula and Waterloo campaigns, the army surgeons usually employed probes to locate the bullet, after which it was extract-

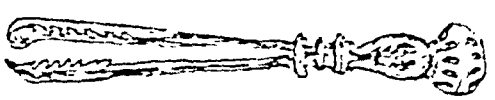


Fig. 68.—An Alphonsine.

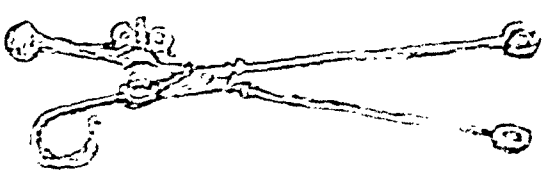


Fig. 69.—Gouch-hill pincers. Scultetus (1674)

ed with the forceps. Ball cartridges had then been introduced in the armies and in 1851 bullets were being used by the British forces.

In comparison with the old methods of detection and location of the bullet, mention must be made of the telephone probe and bullet-detector which was invented by Sir James Mackenzie in 1916.

The apparatus consists of a telephone, to one terminal-end of which may be attached the instrument to be used, while a carbon plate is attached to the other terminal which is applied to the patient's skin, previously moistened with salt water. When the exploring instrument comes in contact with any embedded metals such as lead, nickel, copper, iron or its alloys used in the manufacture of shells, a loud click is heard, or if a rubbing contact be made with the exploring instrument, the click becomes a sharp rattle. Extraction of the foreign body is then carried out in the usual way.

· IX ·

INSTRUMENTS FOR PHLEBOTOMY AND VENESECTION

LANCET · CUP · SCARIFICATOR

PHLEBOTOMY or venesection, in one form or another, has been known to both barbarous and civilised peoples from time immemorial and continued to be practised until it reached its height at the end of the eighteenth century.

"The leech," the old name by which the physician was known, signified the close connection of bleeding with his calling. In primitive times a sharp thorn was the natural instrument employed for pricking a vein, in the same manner as the spiky end of an agave leaf is used by the natives of Mexico. From this to the flaking of a sharp flint for opening a vein was but a step, and this again was superseded by the instruments of iron or bronze in later edges. As time went on we find phlebotomy was practised by the knife or lancet, the cupping vessel and the scarificator.

There is evidence of the antiquity of cupping in the marble reliefs found in Greece as ex-votos in some of the temples while actual bleeding cups of bronze were found among the instruments used by Roman surgeons discovered at Pompeii. *Fig.* 70. Moreover, it is well known that the native tribes of South Africa, as well as the South Sea Islanders, still employ gourds and small horns as cupping vessels and, after placing them against the part of the body from which they wish to draw blood, exhaust the air by sucking through a tiny hole left at the apex.

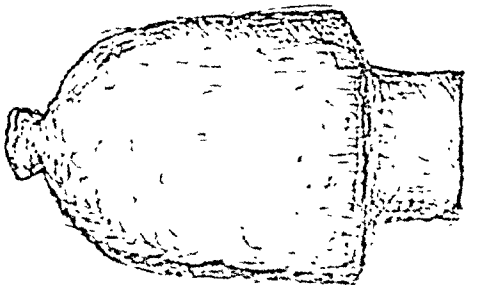
Besides the cupping vessel, the Romans used bronze phlebotomes which took the form of a short double edged blade or a straight shaft with a tooth-like projection fixed at right angles at the end, similar to the gum-lancet of modern times. *Fig.* 71. They also employed horns as cupping vessels.

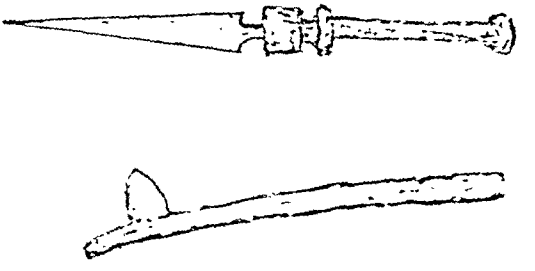
Celsus remarks that "Bloodletting by the incision of a vein is no novelty but it is new to employ it as a remedy in almost all diseases."

showing that although venesection was practised it was not used as a universal remedy. It would appear, however, from his later observations, that both dry and wet cupping were favoured. He thus describes the vessels used: "The brazen is open at one end and closed at the other; that of horn is in like manner open at one end and at the other has a small hole. Burning lint is thrown into the brazen one and in this state its mouth is adapted to the body and then pressed until it adheres. That of horn is applied to the body without this addition and after the air has been withdrawn by the mouth at that part where the hole is, it sticks as well as the other. When it has adhered, if the skin has been previously incised with a lancet it draws blood."

Lucian mentions bleeding cups of silver, and a silver lancet or fleam has been discovered among surgical instruments excavated near Rome. Dry cupping with metal vessels was commonly employed at the Thermae in ancient Rome, and a regular cupper was in attendance who carried with him his instruments, consisting of a set of metal cups, either of brass or bronze, a lamp and a scarifier. For wet cupping he would exhaust the air from the cup by means of his lighted lamp and after making a small incision on the part he would press his cup over the spot to receive the blood. In dry cupping the vessel was applied without first scarifying the body.

In some parts of Greece, Malta and other countries of the Mediterranean, a curious instrument called the phlebotomy bow was employed for bleeding. It was shaped similar to a cross-bow with a blade like a fleam and straight cutting edges. It was operated by a trigger which, on





pressing the stem, flew forward, puncturing the part against which it was applied. Walfer tells us that a similar bow appliance was used in the regions around Panama.

Blood-letting is frequently mentioned in the Anglo-Saxon Leechdoms of the eleventh century and the lancet, cupping-horn and scarifier were employed. Great importance was attached to the time at which the patient should be bled.

It was prescribed as the first treatment in cases of paralysis according to the following directions: "Scarify the neck with a cupping-glass or horn from the sore deadened places, after the setting of the Sun; pour in silence the blood into running water, after that spit three times, then say, 'Have thou this unheal' and depart away with it; go again on a clean way to the house and go either way in silence."

According to the Leech Book of Bald there are special times at which the patient should be bled and the following methods are given to stop the haemorrhage. It is stated "Blood-letting is to be foregone fifteen nights ere Lammas (August 1st) and after it for five and thirty nights since then all venomous things fly and injure men. Leeches who were wisest have taught in that month no man should either drink a potion drink nor anywhere weaken his body except there was necessity for it, and that in that case, he, during the middle of the day should remain within, since the lyft or air is then most mingled and impure. Here is set forth how a man shall forego blood-letting on each of the six fives in the month and when it is best.

FIG. 72 Bleeding a man in the 17th century
From a woodcut (1689).

"Leeches teach that no man on the five nights old Moon and again on the ten nights old and fifteen nights old and twenty and five and twenty and on the thirty nights old Moon, should let blood but betwixt each of the six fives; and there is no time so good for blood-letting as in early Lent when the evil humours are gathered which be drunken in during the winter and on the kalend of April best of all.

"If a lancet wound grow corrupt in a man then take mallow leaves boil them in water and bathe therewith and pound the netherward part of the wort and lay it on. If thou wilt stop blood running in an incision, take kettle soot, rub it to dust, shed it on the wound. Again, take rye and barley balm, burn it to dust; if thou may not staunch a blood-letting

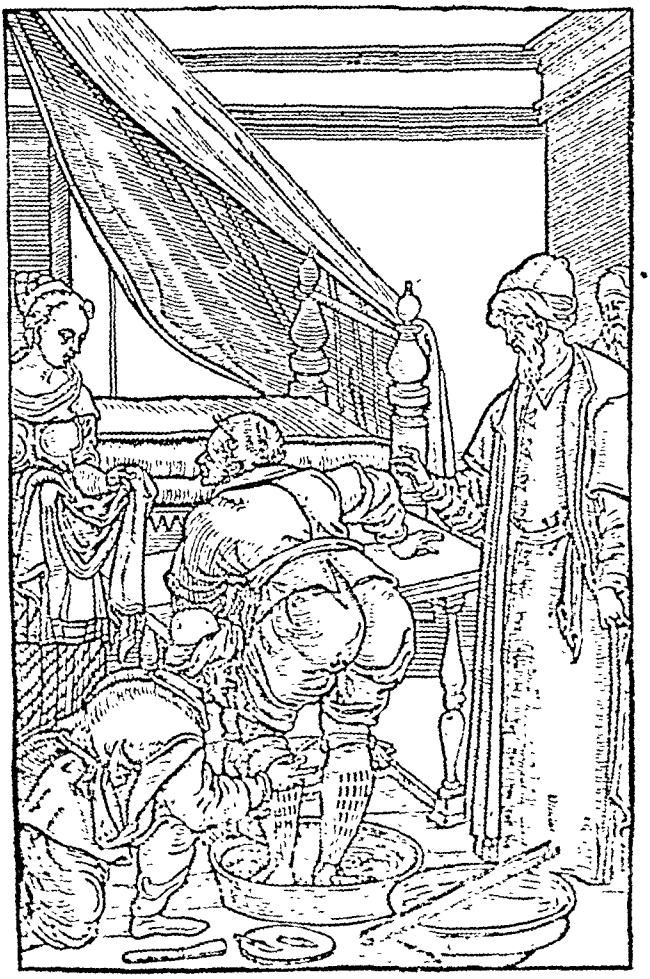


FIG. 73.—Bleeding a patient in the 16th century. From a woodcut of the period.

wound, take a new horses turd, dry it in the sun or by the fire, rub into dust thoroughly well, lay the dust very thick on a linen cloth and tie up for a night. If thou may not staunch a gushing vein, take that same blood which runneth out, dry it on a hot stone and rub it to dust, lay the dust on the vein and tie up strong. If in blood-letting a man cut upon a sinew, mingle together wax and pitch and sheeps grease, lay on a cloth and on the cut."

In the fourteenth and fifteenth centuries when astrology played such an important part in the physician's training, many people were bled at regular intervals, but it was regarded as most important that the operation should only be carried out at certain times when the planets were favourable.

In the monastic institutions the monks were bled frequently and diagrammatic figures were drawn in their manuscripts indicating the proper veins to open and the right times for blood to be drawn.

The following rules for "Lettinge of ye bloode" are laid down in a manuscript of the fifteenth century: "Let not the Moon be in Gemini nor in that signe when you let bloode in yir feete. Let not the Moon be in Capricorn if in ye legges; Let not the Moon be in Aquarius if in ye feete. And the best tyme to let blood is when the Moon is aplyeth to Aries. Let not bloode in the hour of Jupiter or Venus. Let not bloode from the middle of Julie until the middle of September nor when there is frost or snow."

Ptolemy issued a warning to surgeons not to operate when the Moon was in the sign governing a certain part of the body and advised, "Pierce not with iron that part of the body which may be governed by the sign actually occupied by the Moon," a remark which indicated the influence astrology had on medicine and surgery in the Middle Ages. (*Fig. 76* is a figure showing the veins and parts of the body from which a man should be bled and at what period.)

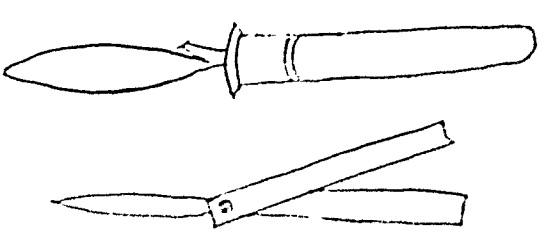


Fig. 74.—Lancets (16th and 17th centuries)

Probably the first allusion to the lancet in English literature is that made by Caxton, 1474, in the lines, "he dyd his vysage to be kutte wyth a knyf and lancettis," showing the instrument was thus known by that name in the fifteenth century; on the other hand, in 1552, Huloet mentions, "Bloude lettynge with the instrument called a fleume." Apparently both names were used for an instrument for opening a vein in the fifteenth and sixteenth centuries, but later, the latter name was chiefly applied to the gum-lancet type of instrument and still remains as the term for the instrument used for veterinary purposes.

Fig. 75.—The veins for bleeding according to the zodiac and months. *Calendarium Romanum*, 1522.

In the Bagnios of London much frequented in the seventeenth century, a cupper was generally in attendance, who according to the bills of the time would perform the operation for "2/6 by the old, or the new way." *Fig.* 77. The latter referred to bleeding with the scarificator, the box-shaped instrument with many short blades that came into use towards the end of the seventeenth century. *Fig.* 78. The box, of silver or brass, was usually square and fitted with from six to twelve small sharp blades slightly curved at the

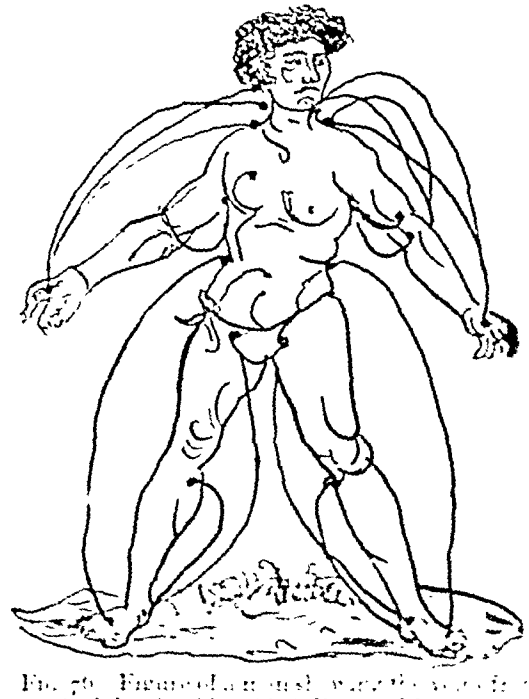


Fig. 76. Figure of a naked woman [illegible]

ends which were controlled by means of a spring and trigger. When the blades were withdrawn the instrument was pressed close to the skin, then by pulling the trigger they were released by the spring and would penetrate the flesh to about the eighth of an inch. The cup was then placed over the spot to draw off the blood.

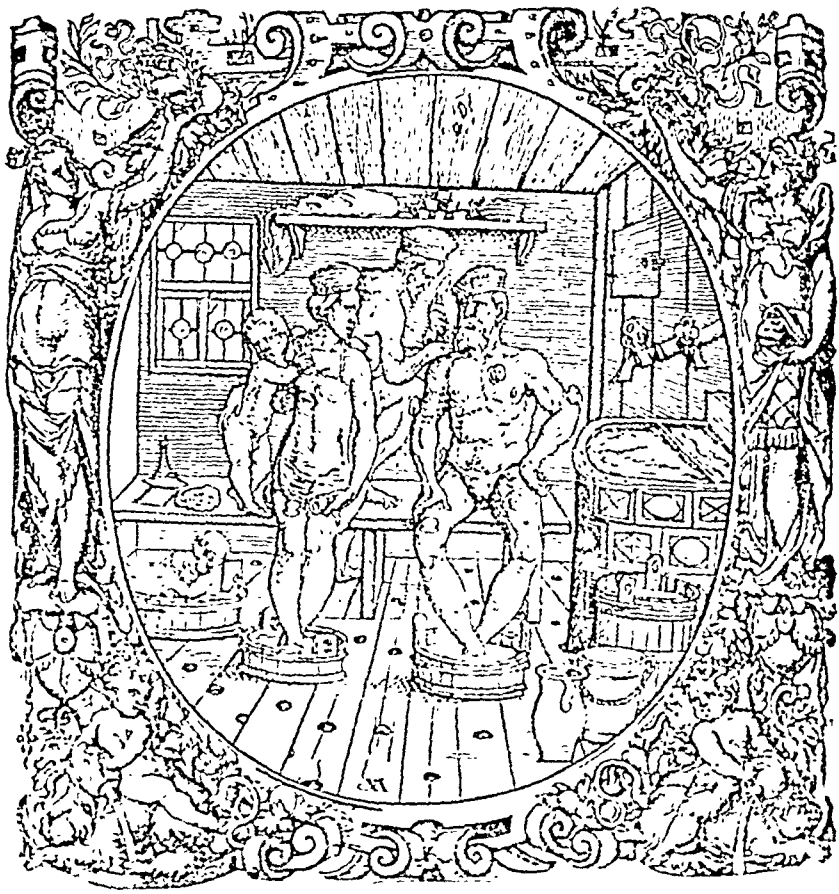


Fig. 77.—The cupper at work after the bath.
From an engraving by Jost Amman (1565).

Later on, a German surgeon invented a small spring-fleam with a single blade called a *schnapper* which worked on the same principle, and penetrated the vein where necessary. Both men and women practised as cuppers in England in the seventeenth and eighteenth centuries as they still do in some parts of France today.

In the eighteenth century during the Georgian era, when the practise of bleeding for nearly every disease reached its zenith, small, flat, silver

cases fitted with from three to half a dozen small lancets were usually carried by the physicians in their waistcoat-pockets to be available on all occasions. The foregoing brief survey of the lancet shows that it has undergone but little change in shape or form from the early centuries of the Christian era to the present day. *Figs.* 79, 80.

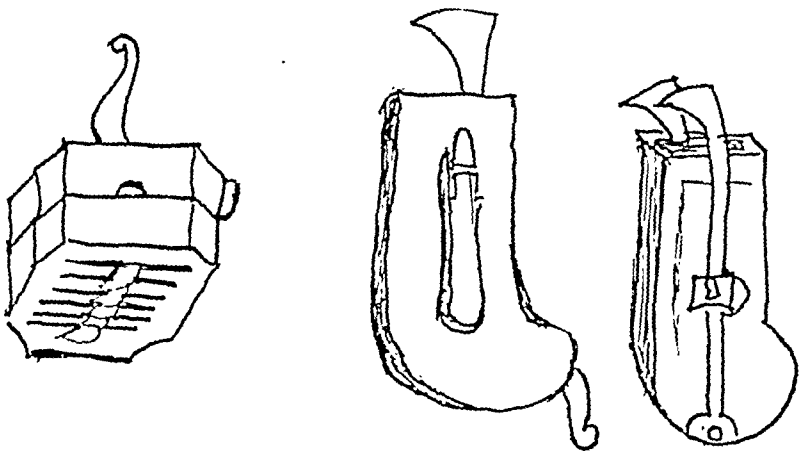


Fig. 78.—A scarificator and spring fleams or schnappers (17th century).

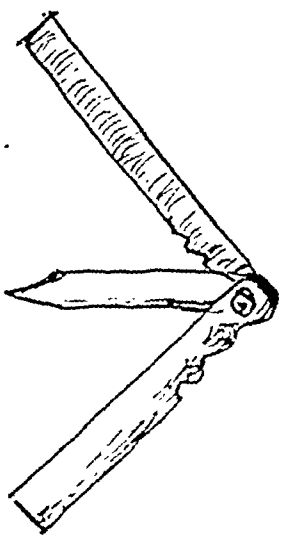


Fig. 79.—Lancet of the 17th century.

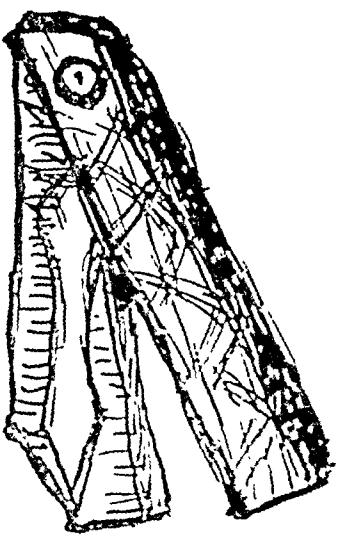


Fig. 80.—Lancet from a 17th century manuscript.

· X ·

TOURNIQUETS

In the primitive surgery of the pre-Christian era, the arresting of haemorrhage from open wounds was chiefly attempted by the simple application of some absorbent substance and binding up the bleeding surface. According to the Anglo-Saxon Leechdom, the method adopted to stop blood running in an incision was to take kettle soot and rub it to dust and place it in the wound. Another way was to "take rye and barley balm, burn it to dust, or a new horse's turd, dry it in the sun or by the fire, rub it to dust thoroughly well, lay the dust very thick on a linen cloth and tie up for a night." The leech goes on to say, "If thou mayst not staunch a gushing vein, take that same blood which runneth out, dry it in a hot stove, rub it to dust, lay the dust on the vein and tie up strong."

The Romans, however, knew something of the action of chemical styptics and Celsus tells us that among the medicines used in his time to suppress haemorrhage were green copperas, burnt lead, chalk, vinegar and iron or copper scales. Specimens of these chemicals were discovered among other materials when excavating at Pompeii.

We know from the writings of Albucasis that the Arabs employed the actual cautery, and later the application of boiling oil was used by military surgeons after amputation until the sixteenth century.

John of Vigo (1460-1519) who was surgeon to Pope Julius II, recommended boiling oil to be applied to wounds in order to destroy the poison supposed to be caused by the gun-powder. All surgeons previous to his time taught that gunshot wounds were poisoned by the powder and cauterising with boiling oil was the only way to destroy the venom.

So this barbarous treatment went on until it occurred to Ambroise Paré, after a fight at the Castle of Villaine where he was serving with the French Army, that a mixture of yolk of egg, oil of roses and turpentine might answer the same purpose and he found it did so without causing pain or inflammation.

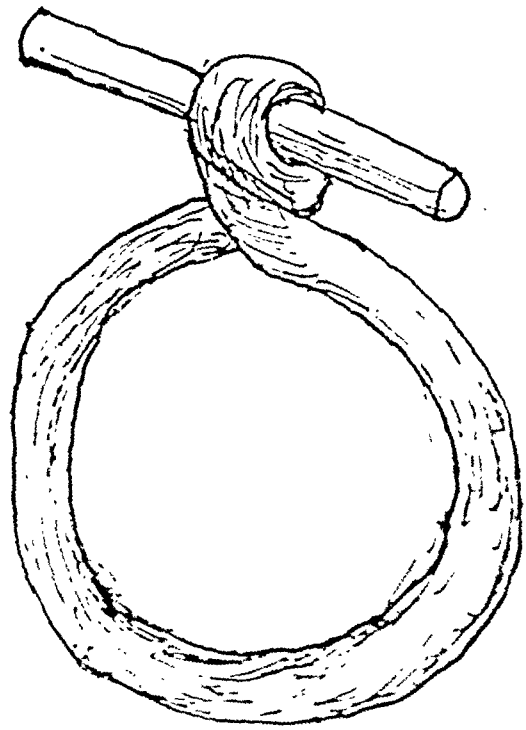
His next important discovery was in 1552 at the siege of Danvilliers, when he amputated the leg of an officer using a ligature instead of the hot cautery iron to arrest the haemorrhage. Thus, although he was not the first to use the ligature, his discovery lay in its application to amputations to arrest bleeding.

It was not until more than a century later that Morell first used his field garrot to arrest haemorrhage from a wound received by a soldier at the siege of Besancon in 1674. This appliance was a simple cord without a pad which was tightened by placing a wooden rod under the loop and twisting it. *Fig.* 81.

In 1678, Young, an English naval surgeon of Plymouth, also claimed that he had used a true garrot in amputations and tells us in a pamphlet how he employed it. He states, "a hard linen wadd was put over the vessels and held in place by a towel passed round the limb, its ends being tied together. The towel was then made tighter by a batton or bedstaff."

Zittier improved on this device and introduced a rack and clip mechanism with a handle to tighten the ligature instead of the stick. *Fig.* 82.

Early in the eighteenth century the axle type was introduced but it was not until 1718, that a new era in the development of the instrument began with the invention of the screw compressor invented by Jean Louis Petit, a leading surgeon of Paris, who gave it the name of tourniquet. He described his invention by means of which he claimed the pressure was limited to the artery, before the *Académie Royale des Sciences* of France in 1718.



With his screw tourniquet he claimed that the pressure was not only limited to the artery but it could

also be held on without special assistance. By this device he declared, relaxation of pressure in order to ascertain if no vessel remained unsecured by ligature, was simple, and the screw could be tightened at once if spouting occurred.

Although some objections were at first raised to its use and Knaur introduced an axle tourniquet in 1796, Petit's type superseded all others. *Fig.* 83.

In 1795, Ehrlich introduced his artery compressor and, a year later, Savigny figured a field-garrot with a handle mechanism for tightening, in place of the stick.

Early in the nineteenth century, Pallas devised a tourniquet with a cog and wheel mechanism and a handle to tighten the band. This was modified by Freeke, *Fig.* 84, but it was regarded as unsatisfactory and Usher Parsons revived the screw type again in 1819. The original Petit's tourniquets were made of wood but brass came to be substituted, and later Perret introduced a modification of Petit's with bearing pins to prevent rotation of the plates. A return was then made to simplicity and in the middle of the century, the chief type used was the strap and buckle that was used in the British Army at the time of the Crimean War. In connection with the tourniquet, mention should be made of some of the instruments devised for tightening ligatures. Such appliances with the ring, as recommended by Rudtorffer, were largely employed but later they gave way again to the strap and buckle.

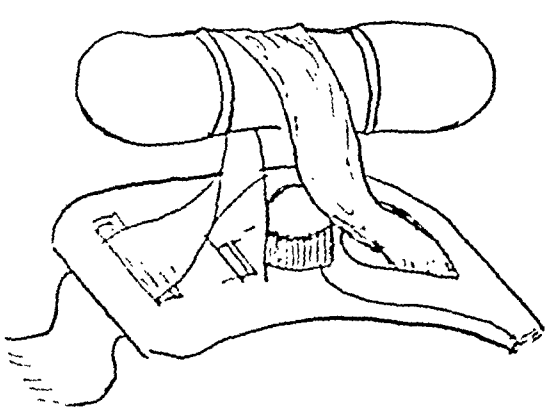


Fig. 82.—Zittler's tourniquet.

In his earlier years, Lord Lister devoted considerable study to the perfecting of the abdominal tourniquet which he considered to be of great importance to surgeons. Until about 1860, no thoroughly efficient instrument of the kind was known and he set to work to supply the deficiency.

The first type he designed consisted of a semi-circular flat bar of steel, its distal ends being apart, so as to enable it to be passed round the patient's loins. The upper extremity terminated in a ball with a hole in it and a screw passing through which was a cylindrical steel rod. At the upper extremity of the rod was a flat oval thumb-piece and at the lower, a steel disc, affixed to which was a convex pad covered with chamois leather, for pressing on the aorta. The lower end of the bar had a brass tube which revolved around it. A hinged brass plate was affixed to this tube and was attached by steel screws to an oval steel plate bearing a pad made for counter pressure on the loins which could move freely on its long or short axis.

In his second model, he had the lumbar pad firmly fixed on a fenestrated base and the free movement of the ball and socket joint transferred to the aortic pad while the body bar was made larger.

In a third model, he had the lumbar pad placed transversely to the bar which he found a great advantage. But he was still not satisfied, and

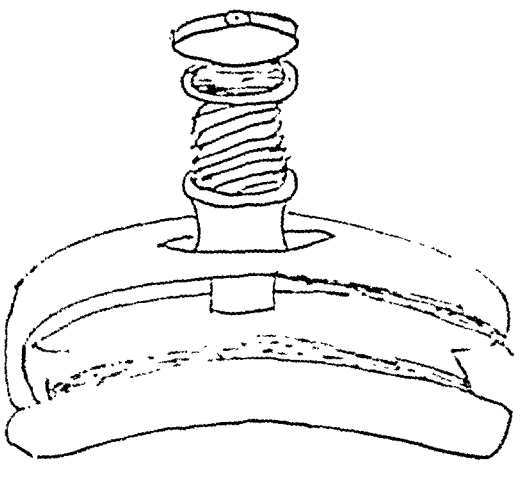
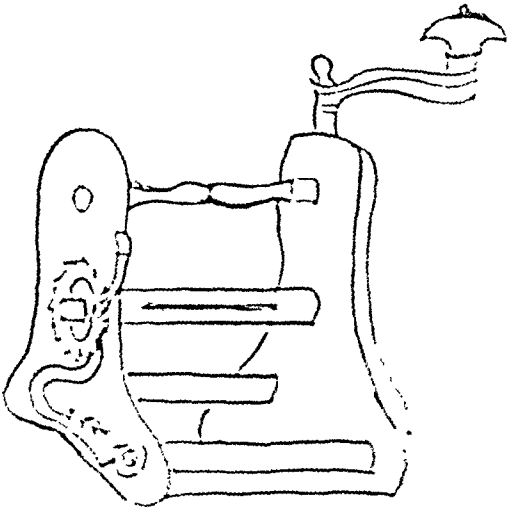


Fig. 8.1 Petit's Wooden Tourniquet
Lister's type 18th century



designed a fourth model which he regarded as the finished and perfect instrument. This is furnished with a firm, large transverse lumbar bar pad with a limited motion that made it stronger.

Specimens of Lister's abdominal tourniquet in the four stages of development are to be seen in the instrument collection in the Museum of the Royal College of Surgeons of England.

· XI ·

TROCARS

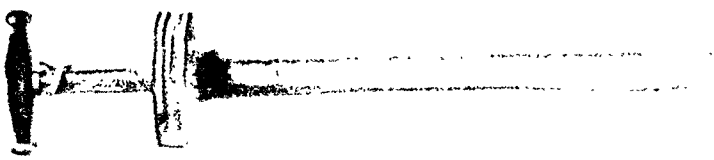
Although the instrument we now call a trocar is of some antiquity it was not known by that name until the eighteenth century. The ancient Greeks knew the means of relieving the body in dropsical conditions but there appears to be no description of any special instrument employed for the purpose. We know, from a bronze instrument discovered among the ruins of Pompeii, that the Romans in the early Christian era employed an instrument for the purpose of tapping similar to the trocar of today. *Fig.* 85.

Celsus[7] gives a lengthy description of the operation and remarks, "it is requisite to tap dropsical patients as I have elsewhere stated. It now remains for me to describe the method of doing it.

"Some perform it below the navel at the distance of about four digits to the left; some perforate the navel itself; some cauterize the integument and then make their opening into the abdomen by incision, because a burnt wound is slower in healing.

"The instrument must be introduced with great care lest a vessel be divided. Its breadth should be about the third of a digit and it is to be inserted in such a manner that it may also pass through the membrane by which the flesh is separated from the abdominal cavity.

"A leaden or copper cannula with its lips curved outwards, or one that has a circular rim at its middle to prevent its slipping into the cavity



is then to be introduced through the aperture. When the latter is used, that part of the instrument which is introduced should be longer than that which remains external to the aperture, in order that it may proceed beyond the peritoneum. Thus, the fluid is to be effused and when the greater part of it has been drawn, where cauterization has not been employed, the cannula must be stopped with a piece of linen rag and left in the wound.

"For some days afterwards, about three heminae are to be discharged until no vestige of the water be remaining.

"Some, however, when the integument has not been cauterized, immediately withdraw the cannula and tie a wet sponge over the wound; then, on the next day, they again introduce the cannula (which is easily done by stretching the wound a little) so that the residue of the humour may escape and they rest satisfied with doing this twice."

Albucasis, the Arab surgeon of the tenth century, mentions a simple exploring needle with a groove mounted on a handle. *Fig.* 86.

Paulus Aegineta also mentions an instrument employed for tapping in dropsy and that a bronze cannula was used by the Romans.

In the seventeenth century, Scultetus in his *Armamentarium,* 1674, describes the instrument then used, as a "little round needle with three points and a pipe with shoulders with which the navels of dropsical persons and the scrotum, in waterie hernia are opened to let out the waters." *Fig.* 87.

The instrument was to be thrust in as far as the "afterism" upon the

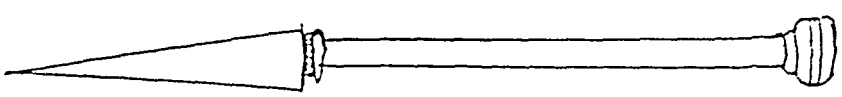


Fig. 86.—Trocar. From Albucasis' Manuscript (12th century).

Fig. 87.—A round needle with three points and its pipe or cannula. Described by Scultetus (1674).

pipe; after the needle is drawn out and the small pipe thrust in as far as the shoulder it is left in the abdomen "without all fear or danger."

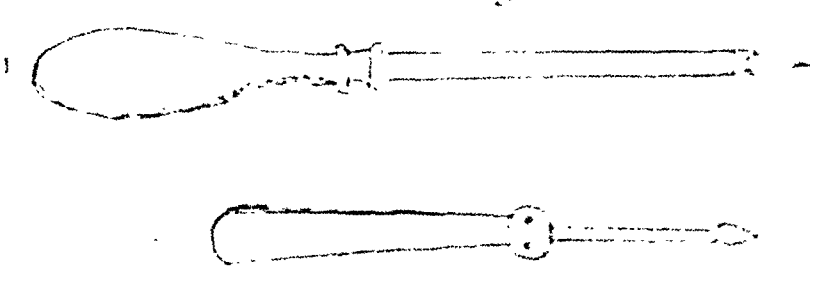
Scultetus figures another type with a round needle and a small pipe which he says "can be used instead of the three-pointed needle by which the navel of hydropsical persons can be perforated with safety."

The name *trocar* appears to have been first used for the instrument by Phillips in 1706 in alluding to "a cane or pipe made of silver or steel with a sharp pointed end used in tapping those who are troubled with dropsy."

Warrack, writing in 1744, in describing the operation, says, "my apparatus was a large trois-quarts made on purpose." From this the name *trocar* appears to have been derived from *Trochartor troise-quarts*, a three-faced instrument, consisting of a perforator enclosed in a metal tube or cannula that was used at that time for withdrawing fluid from a cavity.

From the middle of the eighteenth century, trocars of varied shape and form, according to the purpose for which they were required, were specially made by the instrument makers. Heister figures a flat trocar for tapping in ascites, abdominal cysts and hydrocele, *Fig.* 88 (1). In others the perforator was of a prismatic type with a flattened stem and convex surfaces, the instrument being straight or curved in accordance with the purpose for which it was to be employed. The edges of the cannula were sometimes made to project on each side beyond the trocar, and to others a circular or oblong shield was added, as in that used by Percival Pott.

Until about 1783, cannulas were generally made of silver in one piece and it was not until that time that a change was made when André in-



troduced what he called his "elastic trocar" the cannula of which was divided. The total length of Andrée's instrument was about five inches, the perforator being three and a half inches. The point was shouldered with a concave surface and the cannula was split and made up of two steel plates with a circular base united by screws, which he claimed gave more elasticity than the rigid tube. *Fig.* 88 (2). Savigny later introduced a modification of this instrument having a split on one side of the cannula only, which ran into a circular hole. *Fig.* 89.

Percival Pott, the famous surgeon of St. Bartholomew's Hospital, London, from 1749 to 1787, used a trocar with an oblong shield at the base of the cannula and a perforator with a prismatic terminal. *Fig.* 90 (1).

Benjamin Bell who always used a flat silver trocar for empyemia ascribes the invention of the split cannula to Wallace, a surgeon of Glasgow. The cannula of Bell's instrument was left open on one side which admitted of the trocar being broader through its whole length. *Fig.* 90 (2).

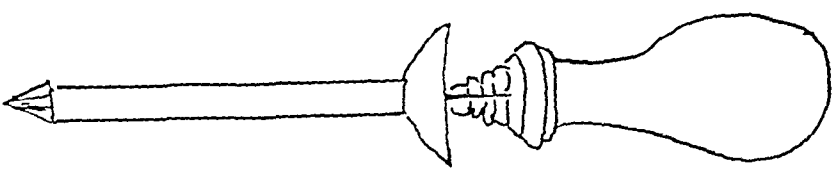


Fig. 89.—Savigny's trocar.

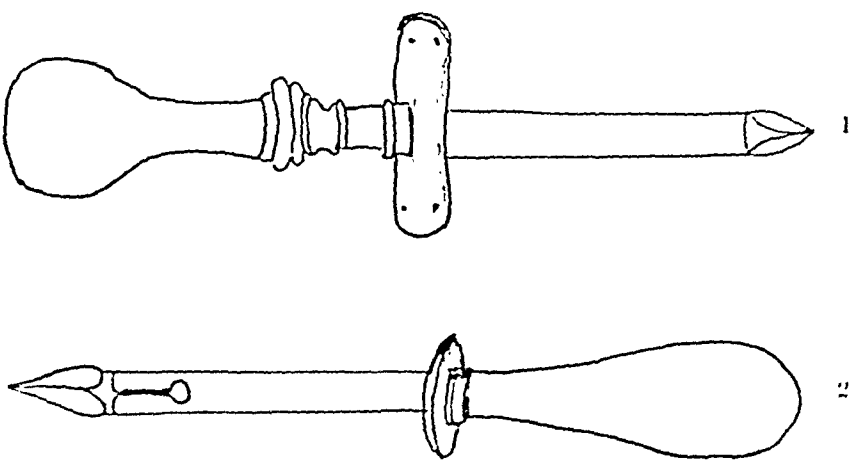


Fig. 90.—Trocars. 1, Percival Pott's; 2, Benjamin Bell's. (18th century.)

Trocars

About 1842, Sir William Fergusson introduced his exploring trocar for tapping in chronic hydrocephalus and in 1880, Murchison invented his trocar and syringe for tapping the chest which proved a useful addition to the instrument.

Sir Henry Thompson (1820-1904), author of many works on pathology and treatment of the urethra, followed with his trocar to which a rubber tube could be attached to evacuate the liquid. This instrument was later improved by the addition of a piston to operate it. *Fig.* 91.

Finally, mention should be made of the trocar ovariotomy syphon introduced by Sir Spencer Wells about 1880, which proved of great value to ovariotomists.

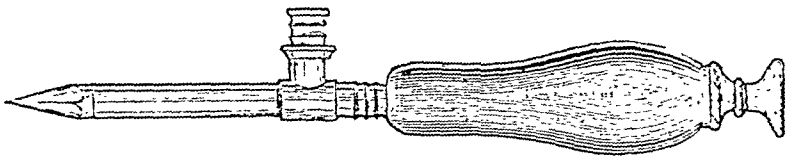


FIG. 91.—Trocar. Sir Henry Thompson introduced a trocar with tube attachment and later improved it by adding a piston, about 1885.

· XII ·

OPERATING TABLES

MAN's knowledge of anatomy in early times is generally supposed to have been derived from the dissection of animals as depicted on the title-page of the works of Galen printed in Basle in 1562. *Fig.* 92. In one of the panels the animal is seen bound to an operating table surrounded by a group of the Fathers of medicine and famous philosophers including Antigenes, Boethius, Paulus and Severus, while Galen himself, in a tall hat, performs the dissection. But thousands of years before that period, we know from the Old Testament, that the priests of Israel cut open the bodies of kids, sheep and other small animals in order to examine their entrails for the purpose of forecasting and divination.

There is also evidence that some knowledge of human anatomy existed in prehistoric times, judging from a curious slab of rock called the "Rivière Stone" that was discovered in the Meraviglie Valley in the mountainous region north of Bordighera in Southern Europe. On it is engraved, what appears to be the outline of the upper part of a human body divided into compartments showing the heart and the intestines. *Fig.* 93. It is thought to have formed part of a sacrificial stone or altar for human sacrifices and it is suggested that the first dissections were carried out on such altar stones.

Fig. 92.—Galen dissecting a pig. From an engraving (1562).

Tables of wood were employed by the Greeks in pre-Hippocratic times and later, we have a description of the *Scamnum* recommended in Hippocratic writings for reducing dislocation of the lower limbs which so often occurred in wrestling matches of the classical period. The original

account of this table, given by the Hippocratic surgeon, reveals that it was a quadrilateral board prepared of about six cubits or a little more in length and about two cubits in breadth and nine digits thick. It was hollowed out from one end to the other so that the working levers might not be higher than was proper, and at both sides there were stout posts provided with axles to the parts, securely fixed, and details are given for using the apparatus. *Fig.* 94.

Celsus refers to the *Scamnum,* which he says was used when other means failed to reduce a dislocated hip, and Paulus Aegineta refers to

Fig. 93.—Prehistoric anatomical diagram on the "Rivière Rock" discovered in the Meraviglie Valley, Southern Europe. (Copyright)

its employment for the same purpose. It is probable that the Roman surgeon used a similar bench for the purpose of performing other operations.

The *Scamnum,* or "luxation table," as it came to be called, was also used by the Arabs, as shown in the drawing from a manuscript of the works of Albucasis written in the fifteenth century. *Fig.* 95.

In this picture, the patient is stretched, face downwards, on a plain bench with four legs which is surrounded by an open framework to which his legs and arms are secured. In the outer framework, the top bar of the apparatus is constructed so it can be extended by a winch in

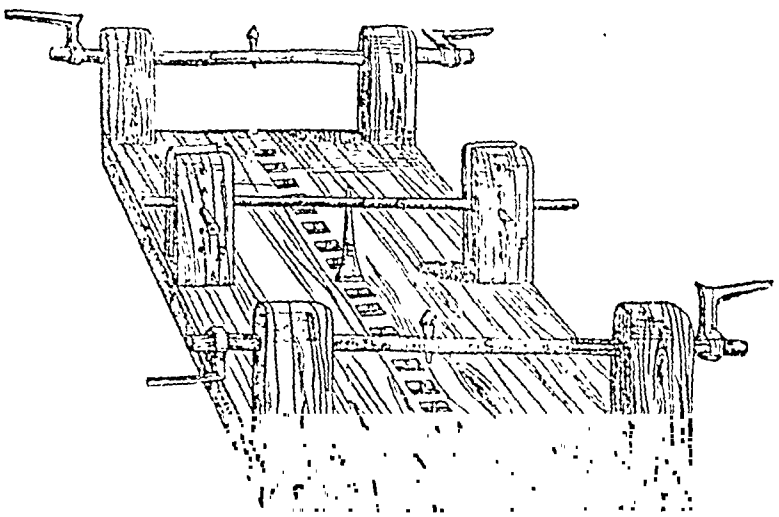


Fig. 94.—The Scamnum of Hippocrates. From a woodcut in Guido Guidi's *Chirurgia* (1554).

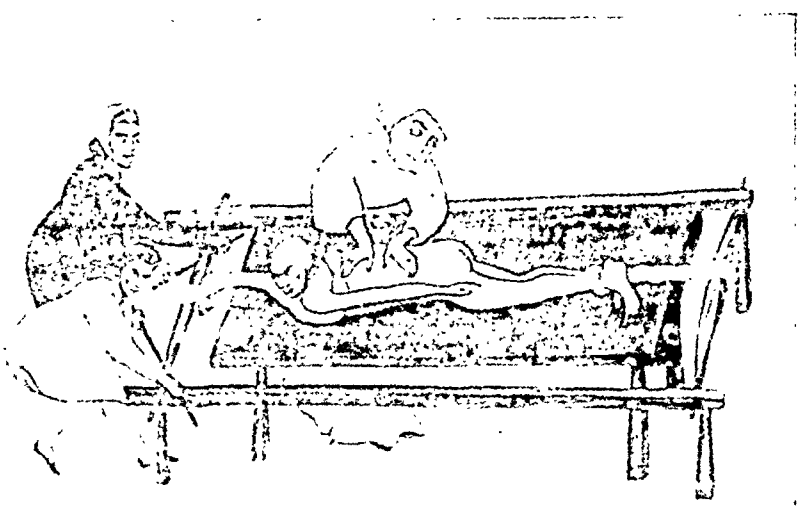


Fig. 95.—An Arab operating table for luxation. From a manuscript. Albucasis (1450).

order to pull the limb into its natural position, while pressure is applied to the patient's back.

In *Thesaurus Chirurgiae,* 1610, there is a woodcut of a patient stretched on a luxation table while a dislocation is being reduced, and apparatus of this kind continued to be employed by surgeons down to the end of the seventeenth century. *Fig.* 96. The *Scammum* was well known to Scultetus, who calls it the "Hippocrates Form." In 1674 he described at length the manner of its use, "lest," he says, "young practitioners may have the same mischance that I knew in my time at Padua, that befell a Chyrurgian and a Physitian who was otherwise most famous for his skill. This man, when he had need of this Form to extend a

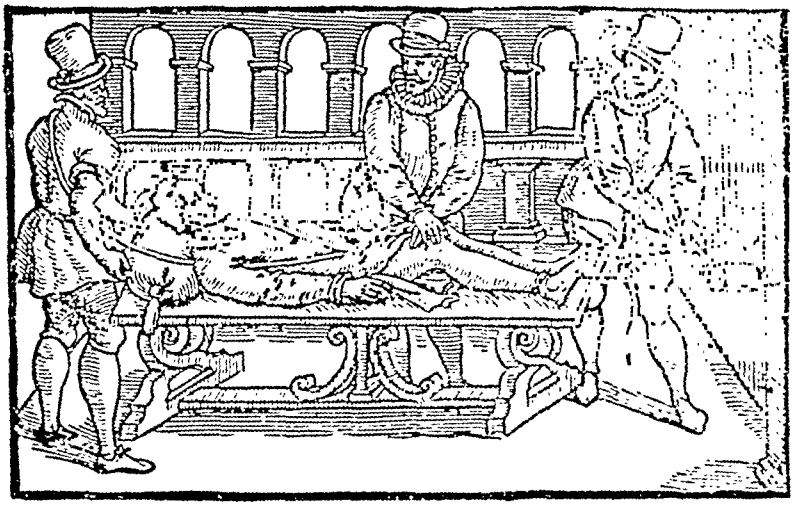


Fig. 96.—An operating table for luxation. From *Thesaurus Chirurgiae* (1610).

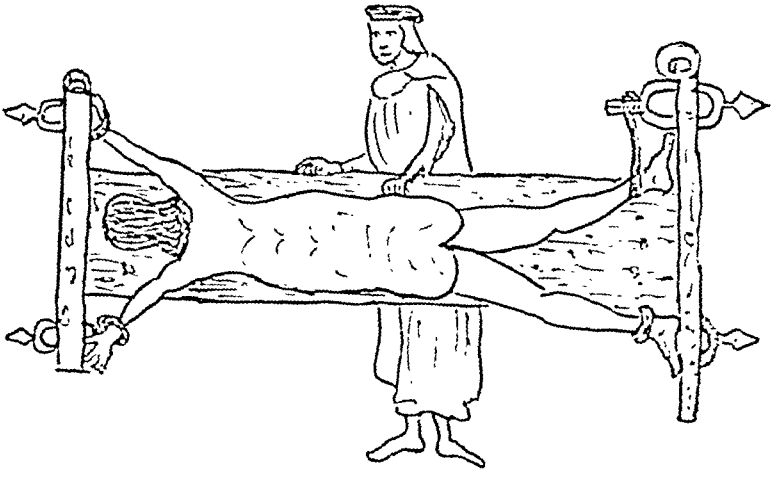


Fig. 96a.—A luxation table. From a manuscript. Gerardus Cremonensis, 13th century.

fracture of the leg but having borrowed it, knew not how to use it; to his disgrace was with shame constrained to learn the use of the Form from the one of whom he borrowed it." It would appear from this that it was about this period the *Scamnum* was going out of use.

One of the earliest known pictures of a patient undergoing an operation is a drawing in an Anglo-Saxon manuscript of the late eleventh century in the Library of Durham Cathedral. *Fig.* 97. The patient is partly reclining on a couch, while the surgeon is applying the actual cautery to his forehead and an assistant is holding a large pair of shears.

In a manuscript of Apollodorus of the thirteenth century, there is an interesting drawing showing the manner in which the patient was secured to the table before the operation. The bench apparently consists of a flat top of boards supported by trestles at either end. *Fig.* 98.

Another drawing in a manuscript of the fourteenth century represents a surgeon operating on the liver. The patient is stretched full length on a table-top, resting on trestles, on which is laid a blanket or rug, and is partly

FIG. 97.—Application of the actual cautery. From an Anglo-Saxon manuscript of the 11th century.

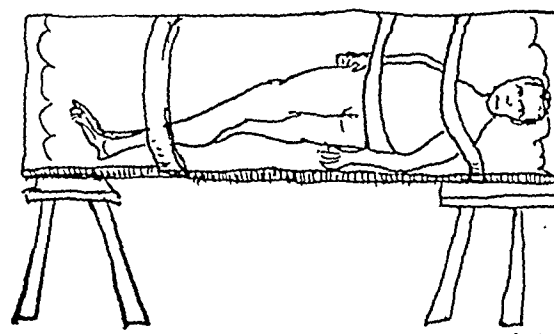


FIG. 98.—An operating table, showing method of securing a patient before operation. From a manuscript of the 13th century. British Museum.

FIG. 99.—An operation on the liver. From a manuscript A.D. 1385).

covered by a sheet. The surgeon is grasping one of his arms while the assistant inserts his fingers in the incision to keep it open. *Fig.* 99. It is probable that the trestle supports, so often used for these tables, were for portability so that they could readily be moved from one place to another. Such a table is illustrated in the work of Bartholomew Glanvil, printed in 1494. *Fig.* 100.

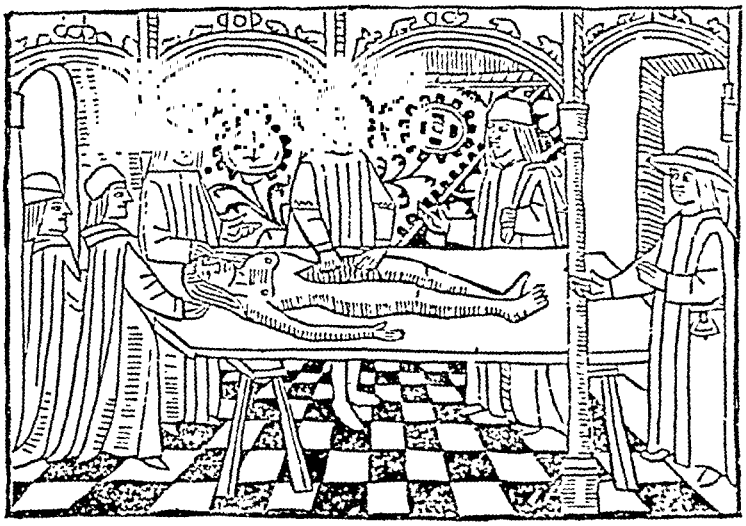


FIG. 100.—An operating table. Bartholomew Glanvil (1494).

FIG. 101.—An operating table of the fifteenth century. From a MS. script *Guy de Chauliac*

Another type of table is depicted in a French manuscript of the works of Guy de Chauliac written in the fifteenth century. The picture represents an autopsy, and the physician is standing by while the surgeon makes the dissection which is being described to the students. *Fig.* 101.

Fig. 102.—An autopsy and demonstration in anatomy. Ketham *Fasciculo medicine* (1493).

There are several woodcuts depicting tables of similar design which were used in the fifteenth century but one of the most interesting is that represented in Ketham's *Fasciculi Medicinae* printed in 1493. *Fig.* 102. This depicts a flat table-top supported by trestles at either end on which the body is laid while the surgeon, knife in hand, is making an autopsy. A physician is directing the operation while the lecturer, seated under the dais, is expounding to the others standing round.

In Jerome Brunschwig's *Buch der Chirurgia,* printed in Strasburg, 1497, a much more elaborate table is depicted, the top being supported by stretcher legs, elaborately carved and fretted. *Fig.* 103.

Coming to the sixteenth century, there are several illustrations of operating tables in the works of Ambroise Paré. One of these, showing a patient about to undergo an operation, is contained in his work on surgery printed in 1573. *Fig.* 104. It depicts a table with a broad top supported by legs with brackets, finely carved, and connected by a balustrated rail. The top is uncovered and the patient's feet are being bound to his sides by the surgeon and his assistant in preparation for the operation. In a later edition of his works, a much improved operating table is depicted, in which the flat-top is supported by turned legs and a back-

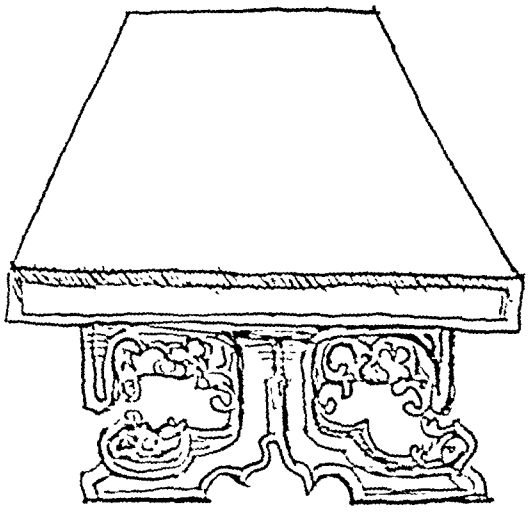


Fig. 103. An operating table. J. Brunschwig *Buch der Chirurgia* 1497

Fig. 104. An operation in Surgery. Ambroise Paré 1573

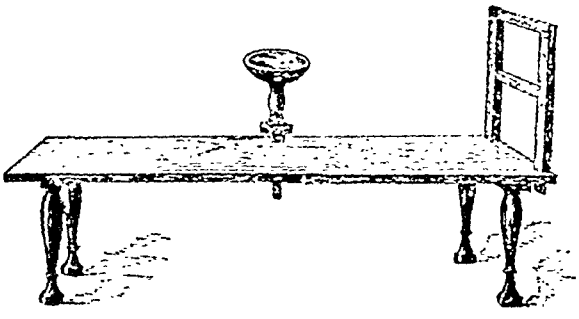


Fig. 105.—An operating table. From Ambroise Paré, 1580.

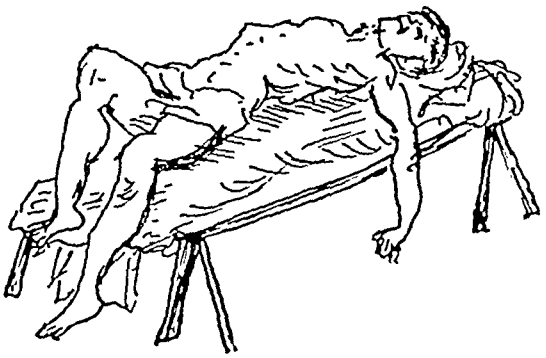


Fig. 107.—An operating table in 1595. From Avicenna's *Canon Medicinae*.

rest is fixed at one end. Midway, on one side, is a bowl for water and dressings, which is attached by a screw to the table. *Fig.* 105.

In the works of Andreas della Croce printed in 1585, there are several woodcuts chiefly showing trepanning operations. In the one reproduced, *Fig.* 106, the patient is stretched face downward on a table with carved legs. The top of the table is covered with a mattress and the body of the patient with blankets, while a pillow is over his feet. Judging from the canopy and the furniture, the picture appears to represent a living-room in the patient's house and the table the one used by the family,

Fig. 106.—A trepanning operation. Andreas della Croce, *Cirurgia Universalia*. (1585).

which had been improvised for the purpose of the operation. Members of the family are attending on the surgeon and on the left, the wife of the patient is seated, stricken with grief.

On the finely engraved title-page of Avicenna's *Canon Medicinae,* printed in Venice in 1595, there is a picture of a surgeon labelled "Galen," who is operating on a man stretched on a table outside a building. The table, apparently a portable one, is on stretcher legs and the top is covered with a soft bed. *Fig.* 107.

In the edition of the works of Vesalius, printed in 1606, there is a woodcut representing an operating table on which are set out a selection

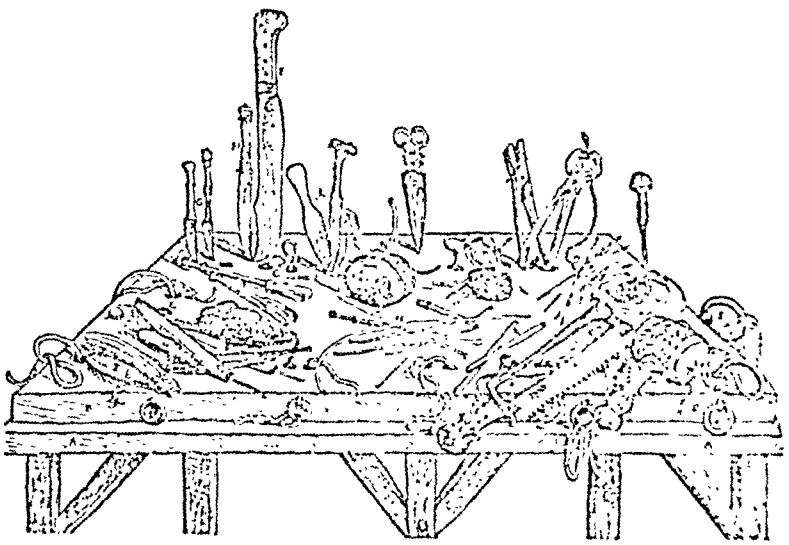


Fig. 108.—Operating table and surgical instruments. Vesalius. 1609.

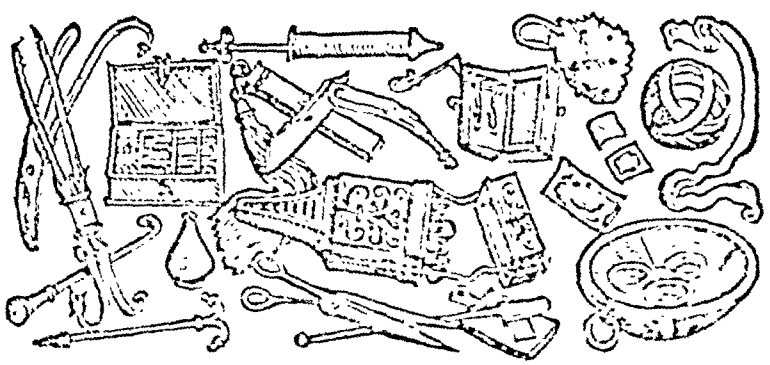


Fig. 109.—Surgical instruments employed in the [illegible]

FIG. 110.—An operation on the eye. Bartisch. *Augendienst* (1583).

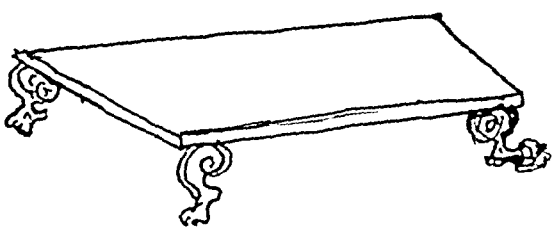


FIG. 111.—An operating table. Guillemeau, 1602.

of the surgical instruments employed at that period. The double-top of the table is supported by strong legs and on the edge of the upper part, are iron rings used for securing the patient during an operation. *Fig.* 108.

Another interesting woodcut showing instruments of nearly a century earlier, appears in Charetanus' *Wundartzney,* 1531. *Fig.* 109. It depicts among others, a surgeon's portable instrument case, an ointment box, bullet-forceps, scissors, a syringe, knives, cupping-vessel with bowl, and a box of *schnappers* for venesection. There are several illustrations of operations on the eye in Bartisch's *Augendienst,* 1583, and the one reproduced, *Fig.* 110, represents a patient lying on a table supported by stretcher legs at each end, the table-top being covered with a soft bed.

In 1602, Guillemeau, in *La Chirurgie Francaise,* depicts a long, low table with carved cabriole legs which was apparently used for trepanning operations, *Fig.* 111, and in 1730, Dionis describes a table with similar turned legs set out with various instruments. *Fig.* 112. This table has a substantial top with bevelled edges and square corners, while on it are arranged the instruments necessary for the operation he describes in the text.

Down to the middle of the nineteenth century the operating tables used in hospitals were entirely made of wood, an excellent example of

which is the one preserved in University College Hospital, London. *Fig.* 113. This historic table was used by Robert Liston, the famous surgeon, when he performed the first operation on a patient under ether in Great Britain on December 21st, 1846.

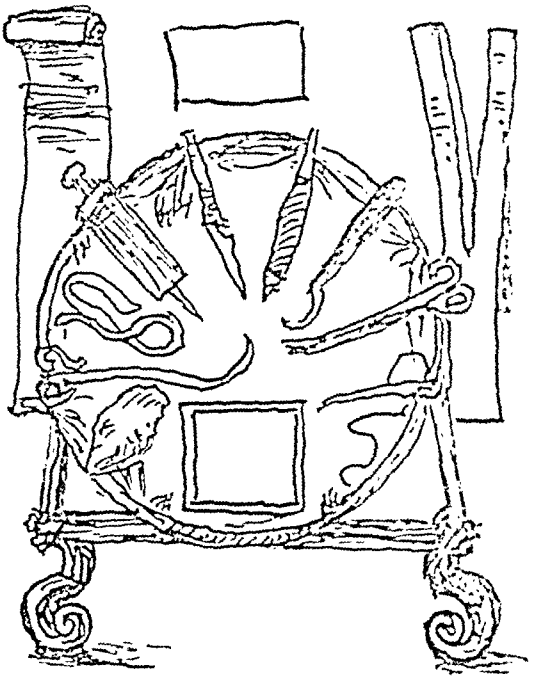


Fig. 112.—An operating table set out with instruments. Dionis (1730).

It is a substantial wooden table about five feet long with four sturdy legs which were secured by angle-irons to the floor. The top, which extended over the legs at one end, was rounded and down the centre are two rows of slots through which straps were passed to secure the patient to the table while the operation was in progress.

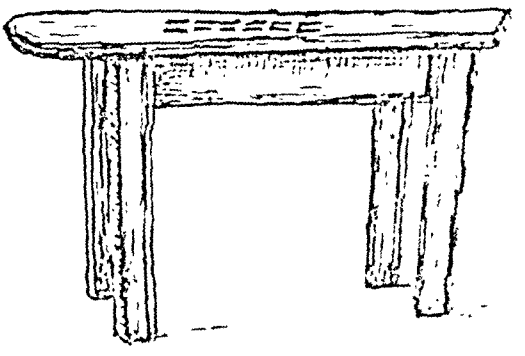


Fig. 113.—Operating table used in University College Hospital by Robert Liston.

Operating tables of wood, sometimes combined with metal, continued to be used with various improvements in the following fifty years and the next development was the adjustable back at one end with a sliding ratchet device to alter the position at the other end. *Fig.* 114.

Tables of metal began to come into use in the latter half of the last century and since the beginning of this century many mechanical and other improvements have been introduced to render them more adaptable to the work of the surgeon. *Fig.* 115.

A comparison of the primitive wooden tables of less than a century ago with the mechanical metal operating tables of today, shows the great advance that has been made in their construction and adaptability in recent times. It may not be amiss to point out, indeed, that whereas the

early surgeons thought of the operating table as the scene whereon they practiced their art, the modern surgeon practices on a scene incomparably more complex and more completely fashioned to supply his every need. In the modern hospital the actual table is now only one part of a highly

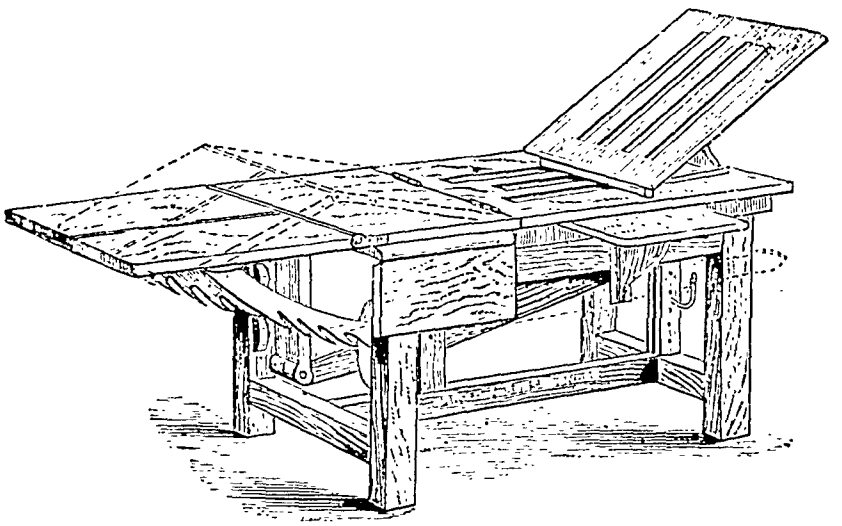


FIG. 114.—A British operating table used in 1885.

organized operating room, the ramifications of which—special air-conditioning, special illumination, special facilities for storage of supplies, utensils and instruments, and for sterilization of everything and everyone concerned—are a story in themselves.

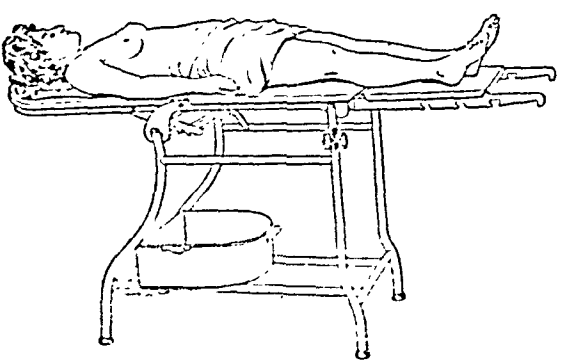


FIG. 115.—A French operating table (1914).

GENERAL INDEX

General Index

Index

Index

Index

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